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ICHTHYOFAUNAL STUDIES OF THE GUNNISON RIVER, COLORADO, 1992-1994

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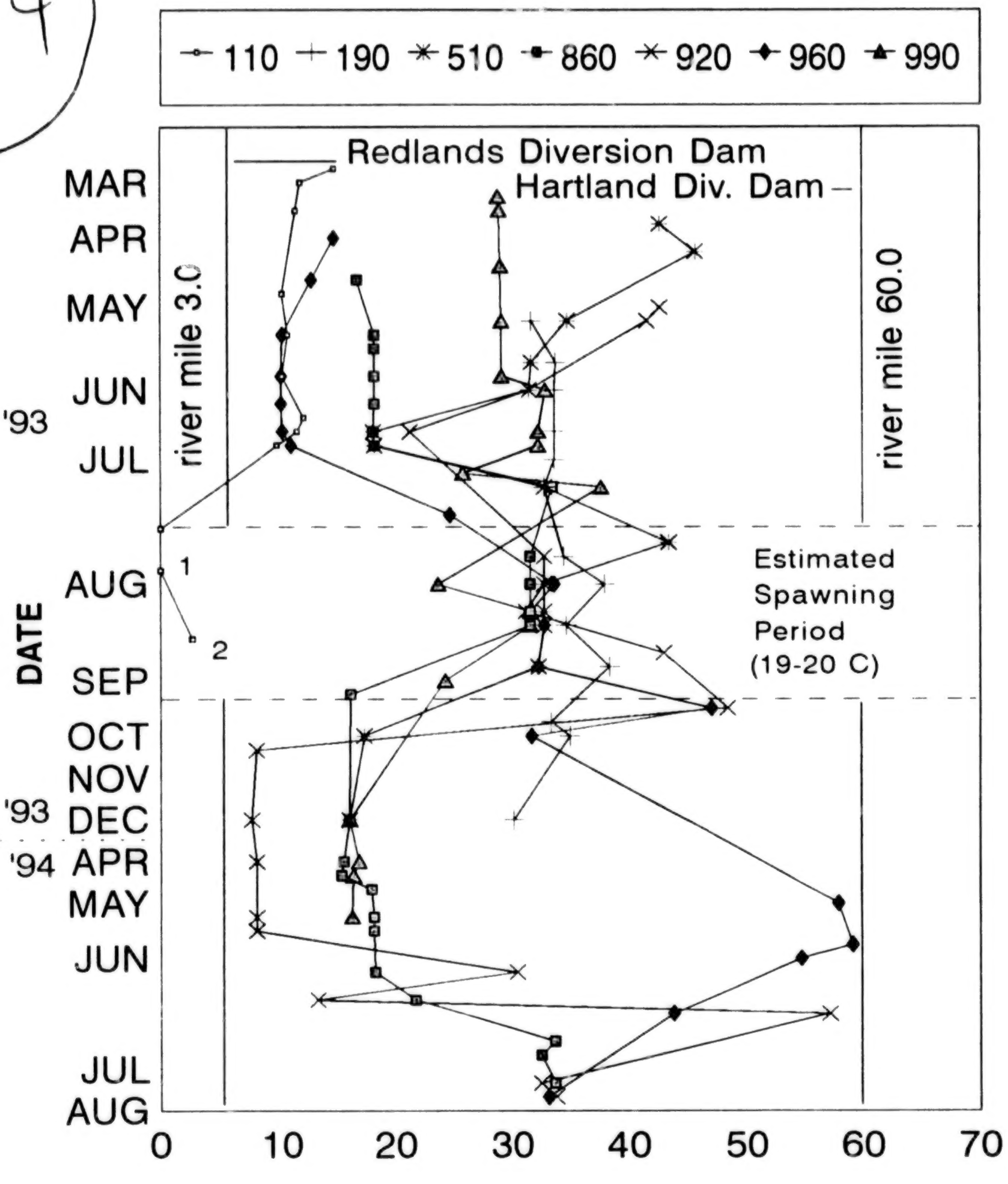

Final Report
December 1995

U.S. FISH AND WILDLIFE SERVICE

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ICHTHYOFAUNAL STUDIES OF THE GUNNISON RIVER, COLORADO, 1992-1994

Aspinall Unit Umbrella Studies
Recovery Program Project Number 42

Final Report

December 1995

Prepared for

Recovery Implementation Program
for Endangered Fishes in the
Upper Colorado River Basin

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Recovery Implementation Program for the Endangered Fishes of the Upper Colorado River Basin, U. S. Fish and Wildlife Service, P. O. Box 25486, Denver Federal Center, Denver, Colorado 80225.

RECOVERY PROGRAM FOR
THE ENDANGERED FISHES
OF THE UPPER COLORADO

DISCLAIMER

The opinions and recommendations expressed in this report are those of the author and do not necessarily reflect the views of the Fish and Wildlife Service or the Recovery Implementation Program.

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List of Key Words: Gunnison River, Colorado squawfish, ichthyofaunal survey, distribution, abundance, radiotelemetry, movement, fish community structure, native fishes, nonnative fishes, electrofishing, seining

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EXECUTIVE SUMMARY

STUDY GOALS AND OBJECTIVES

The purpose of this investigation was to characterize the ichthyofauna of 75 river miles of the Gunnison River from it's confluence with the Colorado River upstream to the confluence of the North and South Forks of the Gunnison River. The objectives were to: 1) assess the distribution and relative abundance of all fish species, 2) evaluate potential spawning of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam using radiotelemetry, and 3) compare the results with former fish inventory studies conducted by the Colorado Division of Wildlife from 1977-1982 and Fish and Wildlife Service in 1981.

TWENTY-FOUR FISHES WERE FOUND IN THE WARMWATER STREAM REACHES OF THE GUNNISON RIVER

Twenty-one species and three hybrids (Catostomidae) were found in the lower 75 river miles of the Gunnison River from the confluence of the North and South Forks downstream to the confluence with the Colorado River in 1992 and 1993. Seven native, and 14 nonnative species, and 3 catostomid hybrids were collected. Of the seven natives, three were endemic to the Colorado River Basin: Colorado squawfish, humpback chub, and flannelmouth sucker. Bluehead sucker, speckled dace, roundtail chub, and mottled sculpin are not endemic to the Colorado River Basin.

NATIVE FISHES DOMINATED THE ICHTHYOFAUNA OF THE GUNNISON RIVER

The Gunnison River still contains healthy populations of native fishes. Although only seven native species were collected numerically, they comprised 79% of the 34,985 fishes collected by electrofishing in 1992 and 1993. Numerically, the eight most common fishes collected by electrofishing in descending order were bluehead sucker (36%), flannelmouth sucker (29%), roundtail chub (14%), common carp (7%), white sucker (6%), brown trout (3%), rainbow trout (2%), and white sucker x bluehead sucker hybrids (1%). These eight species accounted for 98% of the total fish caught by electrofishing. The relative abundance of fishes collected by electrofishing in 1992 (79%) and 1993 (78%) were almost identical; however catch per unit effort declined for both native and nonnatives fishes in 1993 versus 1992.

A SMALL POPULATION OF ADULT COLORADO SQUAWFISH WAS FOUND UPSTREAM OF THE REDLANDS DIVERSION DAM

A small population of adult Colorado squawfish still occurs in the Gunnison River upstream of Redlands Diversion Dam. A total of 13 adult Colorado squawfish were captured up- or downstream of Redlands Diversion Dam in the Gunnison River in 1992 and 1993; five of these 13 fish were collected upstream of the Redlands Diversion Dam in 1993. No Colorado squawfish were collected upstream of the dam during 1992. Two fish that were caught downstream of Redlands Diversion Dam had been previously captured in this same reach between the dam and the Colorado River confluence, one in 1991 and the other in 1992. Upstream of the dam, four other fish were positively sighted but not collected. The reach between Bridgeport and Escalante Bridge was extensively used by adult Colorado squawfish and may be an important area for this species. Three Colorado squawfish during this study were captured within a 0.2-rm reach (rm 33.5 to 33.7). Two of these fish were males captured almost simultaneously in a large eddy at rm 33.7 on 14 July 1993. Both of these males were tuberculated and exuding milt at the time of capture. One female Colorado squawfish was captured in Kannah Creek approximately 300 ft from its mouth with the Gunnison River when flows were rising on 5 May 1993; another was captured downstream at rm 16.7 on the same day. No young-of-the-year Colorado squawfish were collected in hand net, seine, or drift-net samples upstream of Redlands Diversion Dam in 1992, 1993, or 1994. However, two larval Colorado squawfish were collected in mid-July 1992 immediately downstream of Redlands Diversion Dam.

ONE HUMPBACK CHUB CAPTURED

One humpback chub (total length=255) was captured in a deep eddy-pool within a canyon-bound reach at rm 22.0 in 1993. This capture was photo-documented and is thought to be the first recorded capture of a humpback chub from the Gunnison River.

DENSITIES AND YEAR-CLASS STRENGTH OF NONNATIVE LARVAL AND POST-LARVAL FISH WERE HIGHEST IN A LOW-WATER YEAR; DENSITIES OF NATIVE LARVAL AND POST-LARVAL FISH WERE HIGHEST IN A HIGH-WATER YEAR

The magnitude of spring runoff in the Gunnison River was moderately low in 1992 (maximum daily discharge=6,360 cfs) and moderately high in 1993 (20,500 cfs). The larval and post-larval fish community structure of the Gunnison River was dramatically different in 1993 than in 1992. Riverwide in 1992, nonnative fishes collected with hand nets comprised 85% of the total catch as opposed to only 21% in 1993. Relative abundance and CPUE (mean number of fish/sample) values for native and nonnative larval fishes were reversed in 1993 from 1992. There was a ten-fold increase in the number of native fish collected in 1993 compared to 1992. Catch per unit effort for nonnative post-larval fish was reduced by about 50% in 1993 from 1992.

Native species that increased following the high spring flow in 1993 were roundtail chub, bluehead sucker, speckled dace, and flannelmouth sucker. Nonnative species that declined in 1993 were fathead minnow, red shiner, and sand shiner. One notable exception was a 350-fold increase in white sucker in 1993 compared to 1992.

Changes in the post-larval fish community structure from 1992 to 1993 were almost a mirror image of the patterns observed for larval fishes in each of these two years. During the summer following high spring flow, native fish relative abundance riverwide increased from 10% (1992) to 58% (1993) of the total number of fishes collected whereas nonnative fishes decreased from 90% (1992) to 42% (1993). The six most common species collected in descending order were fathead minnow (60.2%), sand shiner (19.5%), red shiner (8.5%), bluehead sucker (4.6%), speckled dace (2.5%), and roundtail chub (1.8%). These species accounted for 97.1% of the total fishes caught with seines in 1992. In 1993, the six most common species collected were bluehead sucker (29.5%), fathead minnow (25.1%), flannelmouth sucker (12.7%), speckled dace (8.2%), roundtail chub (8.0%), and white sucker (6.6%). These species accounted for 90.1% of the total fishes collected in 1993.

Native fish appear to have an advantage during high-flow years, whereas nonnative fish do well in low-flow years. Although the mechanism is unknown, high-water years may have reduced the numbers of nonnative fishes because large backwaters that harbored these species were eliminated and because delayed warming prevented multiple spawning. Nonnative fishes appear to recruit best during low streamflow years but generally quickly recolonize reaches if displaced by severe flash floods. The native fish community is composed of flood-resistant species, whereas nonnative fathead minnow, red and sand shiners, and white sucker are more drought-resistant.

TWENTY ADULT NORTHERN PIKE CAPTURED

Twenty northern pike were caught in 1992 and 1993; thirteen of these fish were captured in a 0.9-mile reach immediately downstream of Hartland Diversion Dam (river mile 60.0). Two male northern pike were captured in trap nets in an oxbow at rm 53.9 in June 1993. Northern pike found during this study in the Gunnison River are most likely downstream migrants from Paonia Reservoir, offspring of parents that were stocked in 1969 and 1970 by the Colorado Division of Wildlife. Other nonnative fishes caught infrequently by electrofishing included green sunfish (0.06%) and black bullhead (0.03%). Six of the ten black bullhead were captured in Reach 1; 13 of the 18 green sunfish were captured in Reach 5. Single specimens of smallmouth bass and largemouth bass were caught in the Redlands Diversion Dam plunge pool.

CHANNEL CATFISH WERE VIRTUALLY ABSENT UPSTREAM OF REDLANDS DIVERSION DAM

Only one adult channel catfish (total length=644 mm) was captured upstream of Redlands Diversion Dam (rm 17). No evidence of successful reproduction was observed from seining collections in the Gunnison River.

SPAWNING BY COLORADO SQUAWFISH WAS SUSPECTED IN REACH 4--RIVER MILES 30-35

Seven adult Colorado squawfish were implanted with radio transmitters in 1993. Five of these fish were captured downstream of Redlands Diversion Dam and released upstream of the dam. A total of 112 individual radio contacts were made periodically with these seven adult Colorado squawfish between 3 March 1993 and 21 July 1994 (458 days). Reach 4 (rm 30-35) appears to be particularly important to adult Colorado squawfish based on the frequency of radio contacts made during this and previous studies. Fifty-four (48%) of the 112 radio contacts were made with radiotagged Colorado squawfish occupying Reach 4. The 5-mile reach between Little Dominguez Canyon (rm 30.0) and Peeples Orchard (rm 35.0) was heavily used throughout the 458-day radio-contact period by six of the seven radiotagged fish. One Colorado squawfish that ultimately moved downstream over Redlands Diversion Dam never frequented Reach 4. The other six fish were in this reach between 20 July and 7 August when surface water temperatures were 19-20°C. Prior to mid-July, five of the six radiotagged Colorado squawfish that would eventually converge to rm 32 and 33 exhibited widespread movements both up- and downstream of this area. Twenty separate radio contacts were made with six different Colorado squawfish between 20 July and 20 August 1993 in Reach 4 between rm 31.6 and 35.6. Five of these six fish were in close proximity between rm 32.8 to 33.7 on 30 July 1993. The estimated spawning period for Colorado squawfish in the Gunnison River was between 20 July and 15 August in 1993. Three of these fish returned to the same site during late-July in 1994.

Convergence of six radiotagged Colorado squawfish in 1993 and three fish in 1994 within a 1-mile section of the Gunnison River during mid-July to mid-August suggested possible spawning behavior. The movement of these radiotagged fish to the same reach in both 1993 and 1994 suggested that this species was attracted to (or homed to) a certain reach during the spawning season. If any or all of the four Colorado squawfish that were captured downstream of Redlands Diversion Dam did not originate upstream, a mechanism other than natal imprinting is operative. Therefore, the mechanism that allowed them to congregate with the two fish that were captured upstream of the diversion dam may not have been innate behavior. But, because we do not have definitive information on the origin of these four Colorado squawfish, it is possible that these fish may have been attracted to the same river location as fish captured upstream of the dam by an olfactory mechanism. There is evidence to suggest that Colorado squawfish exhibit innate homing behavior, but, they may also have the ability of using 'backup' or a combination of mechanisms to locate specific spawning sites based on physical characteristics (e.g., substrate, flow, or staging areas).

RESTORATION ACTIVITIES FOR THE GUNNISON RIVER

Various management-related activities are planned to restore Colorado squawfish and razorback sucker populations in the Gunnison River. Key to this restoration effort is recommending and implementing streamflows that will mimic the historical hydrograph to increase the magnitude and lengthen the duration of spring flows to create and provide riverine habitat for native fishes and at the same time control the smaller nonnative fishes in warmwater reaches of the Gunnison River. High spring streamflows are also necessary to restore natural floodplain functions. Restoration of wetland habitats adjacent to the river corridor that flooded historically but are no longer inundated during runoff is an important factor in the reestablishment of self-sustaining razorback sucker populations in previously occupied stream reaches of the Gunnison River. It is critical that high spring flows be provided to hydrologically reconnect floodplain areas with the river more frequently to provide habitat for early-life stages of endangered fishes. Present theory is that these warmer, off-channel, floodplain areas served as critical nursery habitat for larval razorback sucker by producing hundreds of time more zooplankton than river channels and backwaters.

Construction of a fish passageway at the Redlands Diversion Dam will provide passage for juvenile and adult Colorado squawfish and razorback sucker upstream of the dam. The fishway will extend the range of these two native fishes upstream about 50 miles into historical habitat and may allow Colorado squawfish to naturally re-colonize these upstream reaches. Reaches upstream of the dam are important because they will provide additional physical habitat and a abundant source of native fishes for food. Paramount to the fishway is legalizing flows in the 2.3-mile reach between the Redlands Diversion Dam and the confluence of the Colorado River. In the past, flow has essentially ceased in this reach for several days during low-flow periods which has resulted in loss of habitat and possible stranding of fish. Legalizing flows will provide maintenance habitat and a migration corridor for fishes moving either up- or downstream of the fishway during these low-flow periods.

Stocking will play a major role in reintroducing razorback sucker in the Gunnison River. The Gunnison River has been selected as an initial site for experimental stocking of juvenile and adult razorback sucker. Various sizes (4-inch, 8-inch, and 12-inch) of razorback sucker will be stocked in the Gunnison River over a 5-year period, starting in the fall of 1995, to evaluate the relation between survival and size at release. The short-term goal of this stocking program is to reintroduce fish to stabilize a razorback sucker population in the Gunnison River. The long-range or ultimate goal is to establish self-sustaining populations of at least 10 adult razorback sucker per river mile in the Gunnison River.

FOUR RECOMMENDATIONS FOR CONTINUED STUDIES

Further studies are recommended for the Gunnison River to either monitor or build upon information gathered from this investigation: 1) continue larval and post-larval fish sampling to (a) evaluate spawning of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam, and (b) to obtain additional empirical data on the relationship of nonnative and native fish densities to flows, 2) continue larval drift netting in the Gunnison River at three locations, near Bridgeport, immediately upstream of Redlands Diversion Dam, and immediately downstream of Redlands Diversion Dam to identify upstream adult Colorado squawfish spawning areas and to confirm successful squawfish reproduction, 3) establish trend stations using electrofishing to monitor juvenile and adult fish populations for major changes in species composition and density of native and nonnative fish, and 4) continue movement studies of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam using radiotelemetry to determine if spawning occurs or if the species demonstrates fidelity to a particular area. Such studies might provide insight into the mechanism(s) that allow this species to be attracted or home to certain reaches during the spawning season.

INTRODUCTION

This 3-year study of the fish community in the Gunnison River from it's confluence with the Colorado River near Grand Junction upstream to the confluence of the North Fork is one of several studies examining the effects of construction and operation of the Aspinall Unit on four endangered fishes of the Colorado River Basin. The warmwater reaches of the Gunnison River are considered historical habitat for the endangered Colorado squawfish[1], razorback sucker, and bonytail. Historically, humpback chub have not been collected from the Gunnison River; the nearest known population of humpback chub is located at Black Rocks in Ruby Canyon on the Colorado River 38 river miles downstream of the Redlands Diversion Dam.

The Aspinall Unit (formerly the Curecanti Unit) is a series of three U.S. Bureau of Reclamation (BR) reservoirs (Blue Mesa, Morrow Point, and Crystal) constructed on the upper Gunnison River (Figure 1) as part of the Colorado River Storage Project Act (CRSP) signed into law by Congress in 1956. A number of participating projects were also constructed in conjunction with CRSP. Although these three major reservoirs and other smaller water projects occupy a portion of the Gunnison River that is upstream from historic habitat of the four endangered fish, alterations in flow and water quality have significantly affected the downstream warmwater reaches. The Aspinall Unit was completed prior to passage of the Endangered Species Act (ESA); therefore, its effect on native fishes was not considered before construction began. However, operation of the Aspinall Unit and other CRSP reservoirs continues to effect the endangered fishes and Section 7 consultation under the Act is required on BR's annual operation of the dams. BR's commitments stem from their responsibility as a federal agency to protect these fishes, and where possible, promote their recovery, as prescribed by the ESA.

This investigation of the fish community of the Gunnison River was conducted under the Aspinall Unit umbrella studies which are part of the 15-year ongoing Recovery Implementation Program (U. S. Fish and Wildlife Service [FWS] 1987) of the Upper Colorado River Basin. Results of these studies will be used by the FWS's Division of Ecological Services to write a biological opinion on operation of the Aspinall Unit, as well as to identify recovery actions appropriate for the Gunnison River.

PURPOSE AND OBJECTIVES

The purpose of this investigation was to characterize the ichthyofauna of the Gunnison River from it's confluence with the Colorado River upstream to the North and South Fork confluence of the Gunnison River. Specific objectives were to:

1. assess the distribution and relative abundance of all fish species,

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[1] Scientific names and two-letter codes of all fishes mentioned in this report are in given in Appendix A; Table A.1. Only common names for these fishes are used in the text.

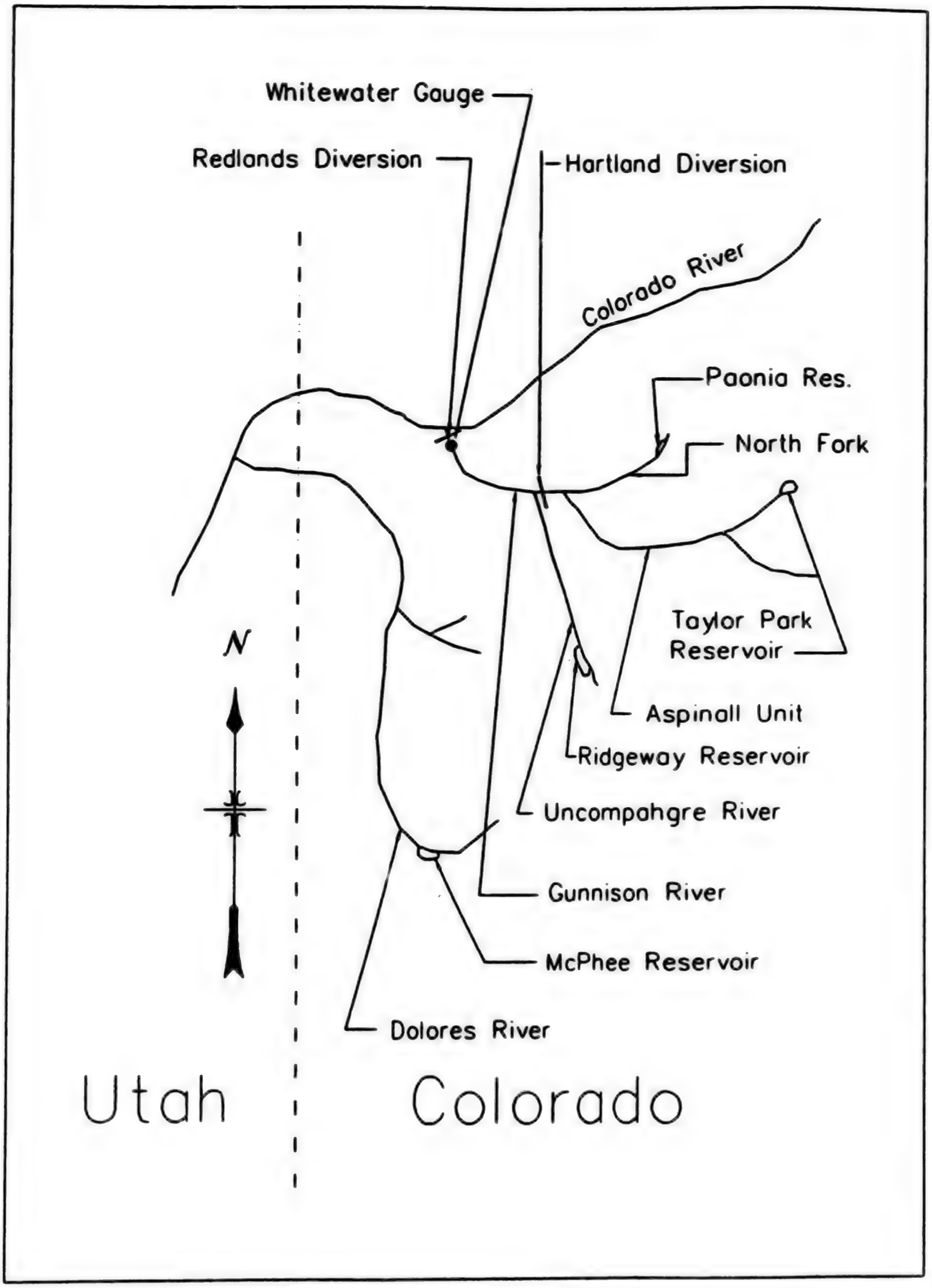


Figure 1. Important features in the Gunnison River drainage.

2. monitor movement and evaluate potential spawning of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam using radiotelemetry, and

3. compare the results with former fish inventory studies conducted by the Colorado Division of Wildlife (CDOW) during 1977-1982 and FWS in 1981.

The warmwater reaches were not sampled between 1982 and 1992 so a thorough evaluation of the present fish community was necessary to make informed management decisions regarding the Gunnison River.

BACKGROUND

Water Development

Private irrigation development in the Gunnison River basin began in the 1880's, with an estimated 180,000 acres under irrigation by 1906 (BR 1990). The Hartland Diversion Dam (river mile [rm] 59.5), about three river miles upstream of the Uncompahgre River confluence near Delta, Colorado, was originally constructed in 1881 for agricultural irrigation and stock-watering purposes and diverts 41-43 cfs into a canal from March through November. This 6-foot high structure repaired and upgraded in 1942 with railroad iron, spans the entire river and effectively restricts upstream movement of fishes during most flow stages. The Redlands Diversion Dam, a barrier to upstream passage of fish, was temporarily constructed on the lower Gunnison River in 1907, and then later moved downstream about 0.5 mile to its present location (rm 3.0) in 1918. The Redlands Diversion Dam has a senior right to divert 680 cfs for power generation and a junior right of 80 cfs for irrigation. The 2.3-mile reach downstream of the diversion dam has been occasionally dewatered continuously for several days, particularly during July, August, or September of low-flow years. Other smaller water diversions on the Gunnison River include the Ferganchick Diversion (rm 70.8), the Austin Diversion near Austin, Colorado (rm 65.2), Broughton Diversion (rm 36.1), and Peeples Diversion (rm 34.6). These three diversions are not impediments to fish movement.

Federal involvement in the Gunnison River basin began in 1909 with the completion of the Gunnison Tunnel, which diverts water from the lower Gunnison River into the arid Uncompahgre Valley. These flows, after being diverted and used for irrigation by the Uncompahgre Valley Water Users, re-enter the Gunnison River via the Uncompahgre River near Delta. Taylor Park Dam, on the Taylor River in the headwaters of the Gunnison, was completed in 1937 to provide water storage for the Gunnison Tunnel. Diversion structures were placed on the Gunnison and Uncompahgre rivers as a part of this project. Annual diversions for this project average about 559,000 acre feet (AF)(BR 1990).

Blue Mesa, Morrow Point, and Crystal reservoirs were completed in 1966, 1970, and 1976, respectively (Figure 1). The Aspinall Unit was constructed to provide water storage and hydroelectric power generation as well as to provide flood control, recreation, and fish and wildlife benefits. Another primary purpose was to store water for delivery to the lower basin under requirements of the 1922 Colorado River Compact. Consequently, these reservoirs store water during spring runoff, and release it gradually throughout the rest of the year. The Unit also produces electrical energy in conjunction with the other dams of the CRSP. The operation of these reservoirs results in a decrease in peak discharge during the runoff period and an increase in flow during the rest of the year. Other water development projects constructed by BR in the Gunnison River Basin include Crawford Dam (Smith Fork Project), on a tributary to the Gunnison River, completed in 1962; Paonia Dam, on the North Fork, completed in 1962, Fruitgrowers Reservoir, a small reservoir on a tributary to the Gunnison River, completed in 1939; Ridgeway Reservoir (Dallas Creek Project), on the Uncompahgre River, completed in 1987.

Historically, the Gunnison River was typical of Colorado River basin tributaries with high, turbid spring flows and clearer low flows from late summer through winter. High spring flows create and maintain braided channels in the Upper Colorado River that provide a variety of important habitats for native fishes (Osmundson and Kaeding 1989; Osmundson and Kaeding 1991). Dam construction has not substantially diminished the total annual flow (mean=1.8 X 10^6 AF) in the Gunnison River. However, the timing of water delivery has been significantly altered by water development projects. The greatest change caused by the Aspinall Unit is the reduced magnitude of spring runoff. McAda and Kaeding (1991a) compared two periods of water development in the Gunnison River basin: mid-development (1939-1965) and post-Aspinall (1966-1993). They estimated that mean-monthly flows measured at the U. S. Geological Survey (USGS) gauge at Whitewater, Colorado declined about 25% in May and 32% in June between the two periods (Figure 2). In contrast, flow during the remainder of the year has increased, particularly during the winter when average monthly flows are more than 100% greater than pre-Aspinall flows. In general, spring and early summer flows have declined, and fall and winter flows have increased. A secondary effect is that water temperatures have decreased during summer and increased during winter. Water temperatures have been reduced from historic temperatures by a maximum of about 1.8°C in occupied habitat (McAda and Kaeding 1991a). This difference probably did not affect adult habitat, but may affect maturation and spawning of adult fish. Although other factors (e.g., changing land-use practices) may have contributed to reduced sediment loads, the average annual suspended-sediment load decreased following construction of the Aspinall Unit. These modifications are typical of the ecological changes in a river after the construction of a large dam (Vanicek et al. 1970). McAda and Kaeding (1991a) provide a thorough discussion of the changes caused by the Aspinall Unit on flow, water temperature, and sediment loads in the Gunnison River and how these changes generally affect the native fish fauna.

Biological Information on Endangered Fishes

Historical information on the distribution of the endangered fishes in the Gunnison River is limited. Jordan (1891) collected both Colorado squawfish and razorback sucker from the Gunnison and Uncompahgre rivers near Delta. He also reported collecting one "bonytail"; however this specimen may have been confused with the more numerous roundtail chub, since they were considered subspecies until 1970 (Holden and Stalnaker 1975). Chamberlain (1946) reported razorback sucker as common in the Gunnison River downstream from Delta, and also reported

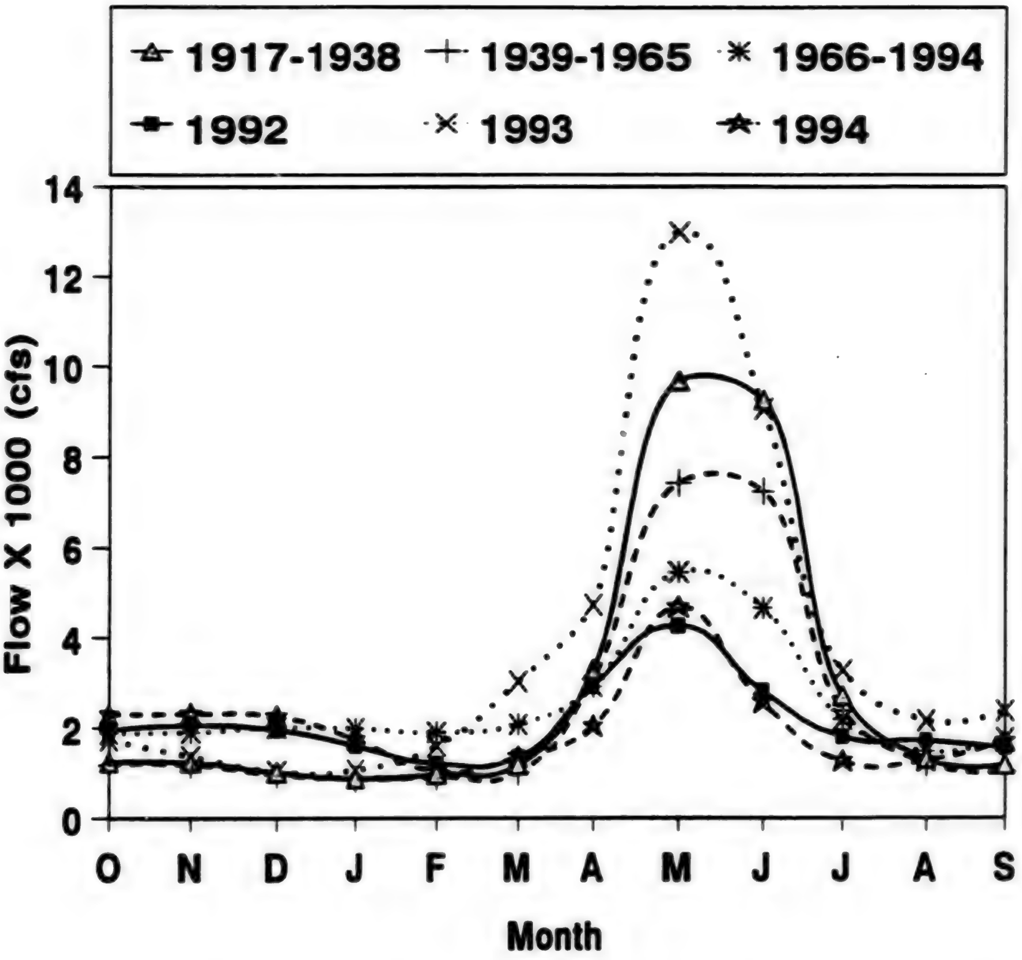


Figure 2. Mean monthly streamflow for the Gunnison River at the Whitewater USGS gauge near Grand Junction for three time periods: early development (1914-1938), middle development (1939-1965), and post-Aspinall (1966-1994) and for three individual years, 1992, 1993, and 1994.

Colorado squawfish from the lower Gunnison River. Kidd (1977) reported that a commercial fisherman frequently collected both Colorado squawfish and razorback sucker from 1930 until 1950 near Delta. Some razorback sucker were collected by CDOW during the 1950's, and one was collected near Delta in 1975 (Wiltzius 1978). Anecdotal accounts also suggest razorback sucker may have been abundant in the Delta area. Quartarone (1993) cites local Delta residents reporting both Colorado squawfish and razorback sucker as common in the Delta area and that razorback sucker used to enter the Hartland Diversion Ditch where they became stranded. Kenneth and Wendell Johnson (Personal communication, 1993), long-time residents of Delta, indicated that they commonly caught razorback sucker in homemade traps in a flooded oxbow that was connected to the Gunnison River during spring runoff. They also added that they noticed that razorback sucker numbers declined rapidly in the late 1950's. Wiltzius (1978) believed that the Redlands

Diversion Dam reduced Colorado squawfish numbers in the Gunnison River by preventing upstream movement from the Colorado River.

Surveys of fish populations conducted on the Gunnison River from Redlands Diversion Dam upstream to Escalante Bridge from 1979 to 1981 did not reveal the presence of any razorback sucker (Valdez et al. 1982a). The Delta area appears to have been the last stronghold of the razorback sucker in the Gunnison River. Holden et al. (1981) captured the last four known adult razorback sucker from the Gunnison River in a 15-mile reach between the confluence with the Uncompahgre River and Escalante Bridge. However, a small remnant population of Colorado squawfish still remains upstream of Redlands Diversion Dam. Valdez et al. (1982a) collected four and observed but did not capture four additional adult-size Colorado squawfish upstream of the Redlands Diversion Dam between 1979 and 1981 and considered them rare. Wick et al. (1985) reported collecting two adult Colorado squawfish upstream of Redlands Diversion Dam in 1981 and one in 1982. Osmundson and Kaeding (1989) collected one larval Colorado squawfish immediately downstream of the Redlands Diversion Dam in 1986. Two larval Colorado squawfish were collected in the Gunnison River downstream of the Redlands Diversion Dam in 1992 (Anderson 1994).

Both Colorado squawfish and razorback sucker have been stocked in the Gunnison River by FWS. Approximately 11,000 fingerling-size (55-140 mm) hatchery-reared Colorado squawfish, marked with coded-nose-wire tags, were stocked in the Gunnison River near Bridgeport (rm 29.3) on 31 October 1984. Twenty-one adult razorback sucker equipped with radio transmitters were stocked in three different backwaters in the Delta area during the spring of 1994. Four additional radiotagged adult fish were stocked in the Gunnison River near Delta in September 1995. This was considered an experimental stocking to determine post-stocking dispersal, general movement patterns, survival, habitat use, and locating possible spawning locations.

STUDY AREA

The Gunnison River, a major tributary to the upper Colorado River, arises at the junction of the East and Taylor rivers near Almont in southwest Colorado. It flows for about 150 miles, primarily in a west-northwest direction, before it empties into the Colorado River at Grand Junction (Figure 1). The basin derives its water supply primarily from the large snow packs that accumulate in the high mountains during the winter. The Gunnison River watershed includes the West Elk Mountains, northern San Juan Mountains, the southern portion of the Grand Mesa, and the eastern side of the Uncompahgre Plateau. The Gunnison River drains about 7,928 square miles (Wiltzius 1978) and contributes approximately 1.85 X 10^6 AF of water or about 14 percent of the total average annual runoff of the Colorado River measured at Lees Ferry, Arizona (Cooper and Severn 1994).

As is typical of tailwaters below large dams, the river downstream of Crystal Dam is too clear and too cold to support warmwater endangered fish. These cold waters extend downstream to the confluence with the North Fork where water temperatures are somewhat ameliorated. After construction of the Aspinall Unit reservoirs, water temperatures are somewhat reduced (about 1-2° C) in the Gunnison River within the historic range of Colorado squawfish and razorback sucker (McAda and Kaeding 1991a). Following the construction of the Aspinall Unit, the transition zone from cold-water species (e.g., salmonids) to warmwater species (e.g., flannelmouth suckers, bluehead sucker, and common carp) is now considered to be between the confluence with the North Fork and Drysdale Flats. Therefore, the upstream limit for this study was established at the North Fork confluence of the Gunnison River.

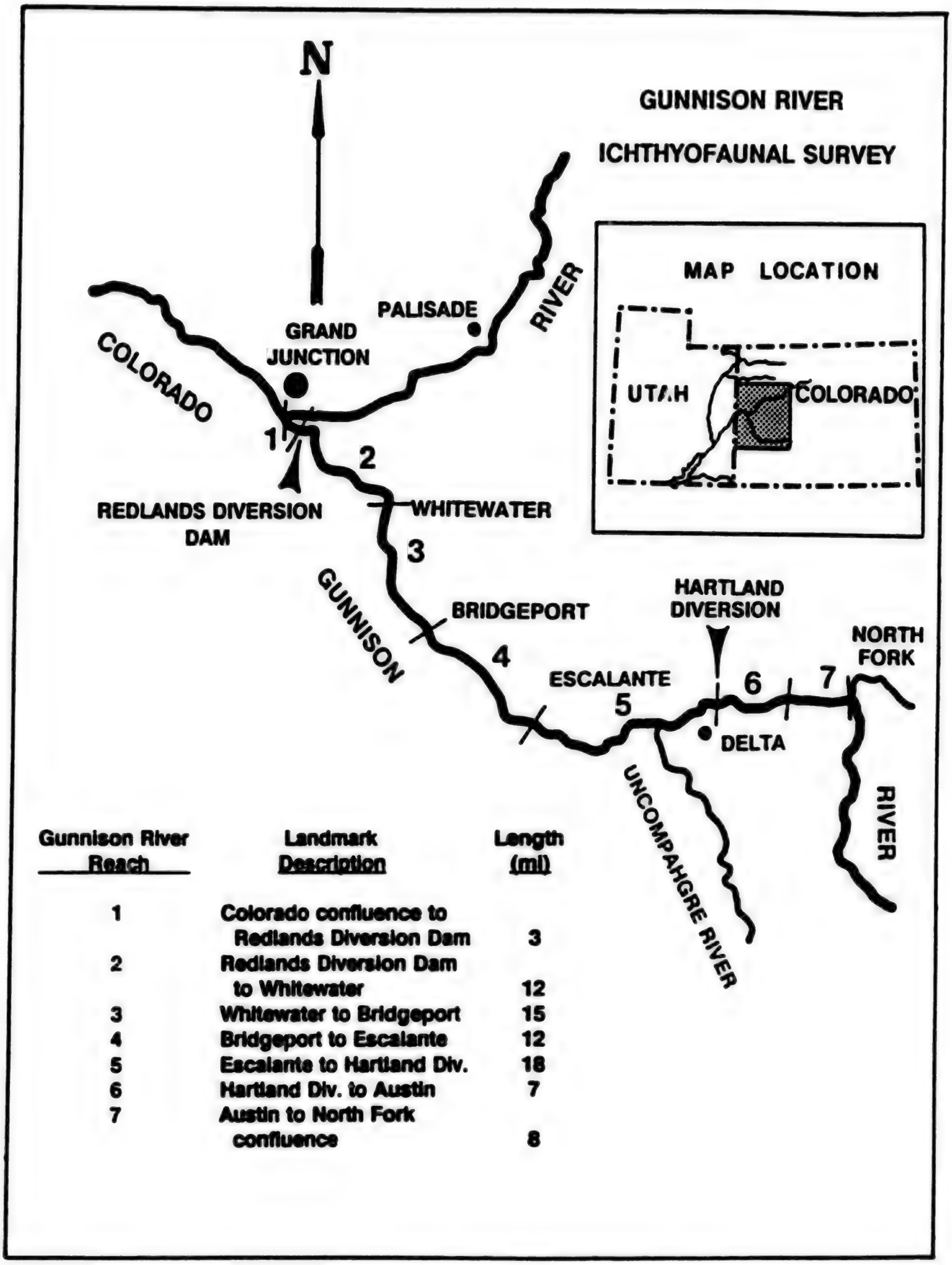
Sampling in the Gunnison River was conducted from the confluence of the Colorado River at Grand Junction upstream to the confluence of the North Fork (Figure 3). For data analysis, the 75-mile-long study area was further divided into seven reaches varying in length from 2.3 to 16 river miles (Appendix B; Table B.1):

Reach 1--Colorado River confluence to Redlands Diversion Dam (rm 0.7-3.0).
Reach 2--Redlands Diversion Dam to Whitewater State Highway 141 Bridge (rm 3.1-14.9)
Reach 3--Whitewater State Highway 141 Bridge to Bridgeport (rm 15.0-29.9)
Reach 4--Bridgeport to Escalante Bridge (rm 30.0-41.9)
Reach 5--Escalante Bridge to Hartland Diversion Dam (rm 42.0-59.9)
Reach 6--Hartland Diversion Dam to Drysdale Flats Boat Landing (rm 60.0-66.7)
Reach 7--Drysdale Flats Boat Landing to North Fork confluence (rm 67.0-74.9)

Reaches 1-4 corresponded to the same study reaches sampled by Valdez et al. (1982a). These same study reaches were used to compare distribution, composition, and density data with former studies (Wick et al. 1985; Valdez et al. 1982a). The land adjacent to the Gunnison River study area is predominately in private ownership (70%). Approximately 16% is owned by the State of Colorado and only about six percent is owned and managed by the U. S. Bureau of Land Management (Irving and Burdick 1995).

Stream gradient in the study area varies from an average of 12.5 ft/mi in (Reach 6) to 5.7 ft/mi (Reach 2). From the North Fork confluence to Drysdale Flats the river flows through a wide canyon with an average gradient of 8.8 ft/mi within this reach. Some of the historical floodplain has been converted to fruit orchards. The most extensive floodplain occurs near Delta from Drysdale Flats (rm 67.0) downstream to Roubideau Creek (rm 50.3). This 17-mile section includes all of Reach 6 and a portion of Reach 5 and has an average gradient of about 10.7 ft/mi. This area contains the highest degree of complex channel habitats which provide the greatest diversity of stream habitats. Numerous braided channels and several large vegetated islands occur in this section, along with riffles, long runs, and backwaters. The flow through this area is moderately fast. These two reaches have also undergone extensive channel modifications and diking. About 3.3 miles of human-made dikes have been constructed in this 17-mile reach to protect the Delta Municipal Sewage Treatment Facility, several gravel-pit mining operations, and other private property (Irving and Burdick 1995).

Reaches 3, 4, and a portion of Reach 5 lie downstream of Roubideau Creek where the river flows through narrow canyons. Although not extensive, some



Gunnison River Reach	Landmark Description	Length (mi)
1	Colorado confluence to Redlands Diversion Dam	3
2	Redlands Diversion Dam to Whitewater	12
3	Whitewater to Bridgeport	15
4	Bridgeport to Escalante	12
5	Escalante to Hartland Div.	18
6	Hartland Div. to Austin	7
7	Austin to North Fork confluence	8

Figure 3. Map of the Gunnison River ichthyofaunal survey area with the seven warmwater stream reaches and general landmark descriptions.

historical floodplains are now occupied by fruit orchards in these canyon areas. Two rock irrigation diversions, Broughton and Peeples, occur in Reach 4, but are not impediments to fish movement. Although there are two rapids in Reach 4, the stream gradient in Reaches 3 (5.9 ft/mi) and 4 (6.5 ft/mi) is lower and the current is slower than Reach 5 (9.3 ft/mi). Near Whitewater, the river widens briefly where gravel-pit operations in historic floodplains presently occur. Downstream from Whitewater, Reach 2, there is a mixture of moderate velocity riffles, quiet shorelines and slow runs; backwaters are uncommon. The stream gradient in this section is about 5.7 ft/mi. From here, the river meanders through a canyon area to the Redlands Diversion Dam. Some gravel-pit operations occur immediately upstream from Redlands Diversion Dam. Reach 1 is immediately downstream from Redlands Diversion Dam. It is the shortest study reach (2.3 miles) and has the third highest gradient, 7.0 ft/mi.

METHODOLOGY

Electrofishing

Study Design and Sampling Gear

Sampling design closely followed that of previous FWS studies (Archer et al. 1980; Miller et al. 1982) conducted by the Colorado River Fishery Project (CRFP) on the Green, Colorado, and Gunnison rivers. Sampling was stratified spatially by study reach (1-7) and temporally by runoff period: 1) pre-runoff (April), 2) runoff (May and June), and 3) two post-runoff periods (July; September and October)(Appendix C; Tables C.1 and C.3). A random sampling design was utilized to establish the river miles to be sampled within each reach. To avoid sampling bias in the selection of river miles, a table of random numbers was consulted and the first number encountered in the table that appeared in the reach was chosen for the first river mile to be sampled. Each study section sampled consisted of two 0.5-mile sections; one extending downstream from the selected river mile starting point; the other five miles downstream. The 4.5-mile intervening section was also sampled (Figure 4). River miles sampled were precisely located either on river maps or aerial photographs. In 1992, sampling was conducted during four different rotations. Rotations usually coincided with flow stage (e.g., pre-runoff, runoff, and post-runoff). In 1992, Reaches 1-5 were sampled four times, Reach 7 was sampled three times and Reach 6 was sampled twice. In 1993, all reaches were sampled three times except Reach 7 which was sampled only during July (Appendix C; Table C.3.). The May and June runoff rotation was suspended to devote time for trap netting a flooded oxbow in an attempt to capture wild adult razorback sucker.

Fish collection and sampling procedures were consistent for each 0.5-mile section and the 4.5-mile intervening section. First, electrofishing crews began at the upstream end of each mile and collected all the fish they could possibly net as they electrofished at a constant rate downstream for 0.5 mile. At this point, all fish collected in the 0.5-mile section were processed. For the 4.5-mile section, electrofishing crews began collecting fish at the bottom of the first 0.5-mile section and continued collecting fish until they reached the upstream end of the second 0.5-mile section. The second 0.5-mile section was sampled last (Figure 4). This protocol was conducted for Reaches 2, 3, 4, and

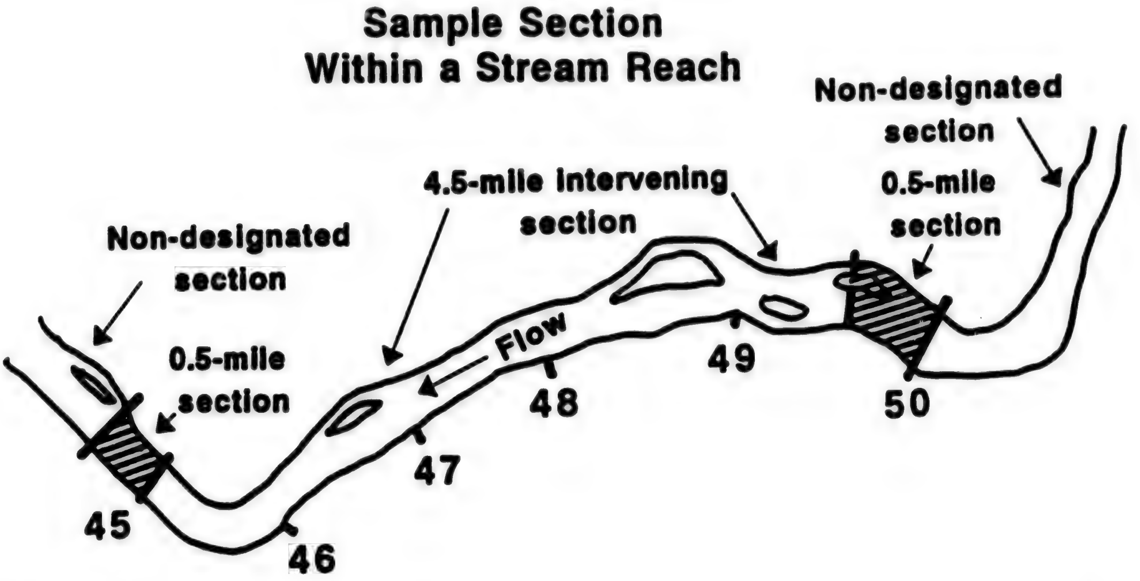


Figure 4. Schematic of sampling protocol for juvenile and adult fishes collected with electrofishing in the seven stream reaches of the Gunnison River, Colorado, 1992 and 1993.

5. Reaches 6 and 7 were entirely sampled as was Reach 1 because it was only 2.3 miles long. Shorelines were the primary habitats sampled in both the 0.5- and 4.5-mile sections. However, all other habitat types that could be reasonably reached by electrofishing crafts were also sampled.

The numbers of fish by species and age category (young-of-the-year [YOY], juvenile [JUV], or adult [ADU]) were recorded on field data sheets at the end of each sample effort. Age-class groupings established in 1979-1981 by CRFP (Miller et al. 1982; Appendix D; Table D.1.) were used. Effort was recorded in seconds which was later converted to hours electrofished. Notes were recorded for all visible lesions and parasites, sexed (if possible), and if fish were tuberculate. All fish collections were accompanied with detailed information regarding location, date, time of day, habitat type, conductivity, water temperature, and voltage and amperage output of electrofishing equipment. All fish were weighed (g) and measured (total length [TL], mm) if they were not stressed. However, if a large number of fish were collected and they became stressed while being held, only fish from every other "net scoop" were weighed and measured. In the 4.5-mile section, electrofishing crews usually stopped every mile, or whenever there were too many fish for the holding container, to obtain the necessary information on captured fish. Data sheets were completed and the elapsed-time clock on the VVP-15 was reset after each 0.5- and 4.5-mile section.

Because electrofishing crews had to proceed downstream to sample designated sections in the next reach, sampling was also conducted in the non-designated sections. The sampling gear and technique were exactly the same as for the 0.5- and 4.5-mile sections, but fish collection procedures in the non-designated sections were slightly different. The non-designated section was electrofished for the entire length but only target endangered fishes and fish that were infrequently seen or of special interest (e.g., channel catfish, northern pike, green sunfish, and black bullhead) were collected, counted, and released. All Colorado squawfish and northern pike that were collected either in the 0.5-, 4.5-mile designated sections, or non-designated survey sections were weighed, measured, PIT tagged, and released. All Colorado squawfish captured up- and downstream of Redlands Diversion Dam were scanned for a coded-nose-wire tag to determine if they were hatchery-produced fish previously stocked in the river.

Electrofishing was used primarily to collect juvenile and adult fish. Sampling was conducted from both an outboard-powered, aluminum electrofishing jon boat and from a hypalon raft, each 16-foot long, equipped with a 5-kilowatt generator and a Coffelt VVP-15 voltage pulsator to adjust the voltage and amperage transmitted to the water. The electrofishing boat used two spherical anodes (about 9-inch diameter) suspended from fiberglass booms in front and two 7-ft cathodes (0.25-inch diameter twisted cable) suspended from each side of the boat. The boat was also used as a cathode in conjunction with the droppers. The electrofishing raft used one 11-inch sphere each for the anode and cathode. Both the anode and cathode were stainless steel on both craft. Investigators used direct current and tried not to exceed 300 volts or 12 amps to minimize injury to fish, while maximizing electrofishing effectiveness. Motorized electrofishing jon boats facilitated maneuvering into eddy habitats, fast current shorelines, and traveling upstream to sample fish that was difficult for oar-powered rafts.

Trammel nets, 1.0- and 1.5-inch bar mesh, with a wall of 10- or 12-inch were used sparingly throughout the study. They were used during high spring flows in tributary and canyon mouths and in autumn 1992 in deep pools from rm 33.7 to 25.3. Trap nets were used to capture wild razorback sucker for about three weeks in May and June 1993 in an oxbow downstream from Delta (rm 53.9: Johnson Boy's Slough) that connected to the river during flood stage.

Hand Nets and Seining

Study Design and Sampling Gear

Two different periods were sampled for larval- and post-larval-size fish. Sampling for larval fish was conducted during the first week of August in both 1992 and 1993 (Appendix C; Table C.2). Post-larval fish were sampled during the second week in September in both 1992 and 1993 (Appendix C; Table C.3). Only Reaches 2-5 were sampled for both larval and post-larval fishes. Data collection for each of these two sampling periods was similar to that established by the Interagency Standardized Monitoring Program (ISMP; McAda et al. 1994a) that is used to systematically sample YOY Colorado squawfish in the Upper Colorado River Basin. However, because this was a riverwide inventory intended to describe fish community composition and distribution, protocol for selecting specific habitat types (e.g., backwaters) to be sampled did not follow the rigid criteria established by ISMP (McAda et al. 1994a).

Each reach sampled was divided into 5-mile subreaches which formed the basis for the sampling design. At least two backwaters or other low-velocity habitats were sampled in every 5-mile subreach. At least two seine hauls per sample site were taken. If time permitted, all backwaters in a reach were sampled. Fish that could be reliably identified afield were counted and released alive. The remaining fish were preserved in 10% formalin for later identification and enumeration in the laboratory. Fish were identified to species, counted, and measured at the Larval Fish Laboratory, Colorado State University, Ft. Collins, Colorado. For the post-larval sampling, physical parameters were recorded for each sample: 1) length and width of the seine haul, 2) total length and average width of each backwater, 3) maximum depth of the backwater, 4) maximum and average depth of each seine haul, 5) average substrate size for each seine haul and for the backwater as a whole, and 6) water temperature in the backwater and adjacent main channel (± 1°C). Effort for larval sampling was 1 for each attempt. Post-larval sampling effort was recorded as area swept by the seine (m^2).

Small hand nets (0.5-mm bar mesh) about 3-ft square were exclusively used to collect larval fish. Post-larval fishes were collected with a 1/8-inch mesh seine, 30-feet long and 6-foot wide that was hung with double weighted lead line so that it would remain on the bottom.

Radiotelemetry

Colorado squawfish

Radiotelemetry was used to study the movement of adult Colorado squawfish, and to identify possible spawning areas. Adult Colorado squawfish collected in 1993 were surgically implanted with either 280- or 360-day radio transmitters. Advanced Telemetry Systems (ATS) radio transmitters were equipped with an internal loop antennae, powered by a lithium battery, emitted a unique frequency signal in the 40 Mhz frequency band, and weighed 16-20 g. Implanted fish weighed at least 1,000 g to assure that transmitter weight was no more than 2-2.5% of their body weight. All fish were implanted in 1995 between 3 March and 7 May. Following capture, all fish were held in a holding tank with 0.5% salt (by weight) solution. Fish were then anesthetized with MS-222, weighed, measured, and PIT-tagged. Surgical procedures for implanting the radio transmitter followed that of Hart and Summerfelt (1975) and Tyus (1984). Fish captured upstream of Redlands Diversion Dam were released near the point of capture after recovering from surgery. In 1992, because no adult Colorado squawfish were captured upstream of the dam, the decision was made to radiotag up to five adult fish in 1993 that were captured downstream of the dam and translocate them upstream of the dam to different points. The five fish that were captured downstream of Redlands Diversion Dam in 1993 were allowed to recover from the anesthetic and were then transported in a 225-gallon tank with 0.5% salt by vehicle upstream and released either at the Whitewater Bridge (rm 14.7), the Bridgeport Boat Landing (rm 29.3), or the Escalante Bridge (rm 42.7).

Radiotagged fish were tracked by boat during subsequent electrofishing sampling trips in 1993 and about monthly during autumn and winter 1993, and spring and summer 1994. An aluminum-jon boat with a 65-horsepower jet drive facilitated up- and downstream travel to monitor movements of radiotagged fish. During July and August 1993, tracking effort was intensified to monitor radio-tagged fish more closely and to identify the time and location of possible spawning. An ATS digital radio search-receiver with either an omni-directional whip or bi-directional loop antennae was used for all tracking trips. The location of each radiotagged fish was fixed by triangulation (Bovee 1986; Tyus 1988). Locations were recorded in river miles upstream from the confluence with the Colorado River. Other pertinent data collected for each contact were general habitat type at the signal source and surface water temperature.

Data Compilation and Analysis

Data were recorded in the field on standardized data forms. These data were then stored in the database management system, DBASE III+, to facilitate access and analyses as well as to provide data compatible with the computer system and format used by the ISMP database. Computer diskettes containing the corresponding DBASE III+ files from this study are available upon request through the ISMP database manager, FWS, CRFP, Grand Junction, Colorado.

Capture data for juvenile and adult fish were analyzed by various methods. Total catch per unit of effort (CPUE: total fish collected/total hours sampled [F/h]) was used to determine relative density of fish in electrofishing collections. CPUE was calculated for each fish species and hybrid by reach and by sampling rotation for 1992 and 1993. Only fish collected in the 0.5- and 4.5-mile sections were included in calculating CPUE. In a few instances, effort was not recorded and CPUE could not be calculated. Fish collected in these samples were included in the total catch but were not used for CPUE calculations. Species composition and relative abundance (expressed as a percent) were used to describe the fish community by reach and sampling rotation for 1992 and 1993. The frequency of occurrence for all species was determined by the number of samples in which a species was collected.

One study objective was to determine if major changes had occurred in species composition and relative abundance of the fish community from previous studies (Valdez et al. 1982a; Wick et al. 1985) conducted on the Gunnison River. The numbers of fish collected by electrofishing and from seining and the effort required to catch fish by these methods were retrieved from former studies and CPUE was re-calculated to compare with this study.

Length- and weight-frequency data were examined for the most commonly collected species for each reach to determine the relative size structure of the juvenile and adult population for 1992 and 1993. Mean TL was used to determine population size-structure trends for three commonly collected native fish species (bluehead sucker, flannelmouth sucker, and roundtail chub) and one commonly collected nonnative species (white sucker). These data were further partitioned by reach and by sampling rotation for 1992 and 1993.

Radio tracking data were examined to determine: 1) total number of radio contacts per fish, 2) duration or total number of days that a fish was contacted, 3) total number of river miles that a fish moved, from the most upstream contact to the most downstream contact (total longitudinal movement), 4) maximum distance and direction that a fish moved from point of release to the point of last contact, and 5) time of day, date, and location of fish aggregations.

Streamflow and water temperature records for the Gunnison River were obtained from the USGS stream gauging station at Whitewater, Colorado (no. 9152500). The mean daily flow and mean daily maximum water temperature were plotted for the 1992 and 1993 water year. These mean values were also correlated with the time and location that radiotagged Colorado squawfish congregated in July and August 1993 to estimate the spawning period.

RESULTS AND DISCUSSION

Electrofishing Collections

Endangered Fishes

During 1993, two of the four mainstem endangered fishes, the Colorado squawfish and humpback chub, were captured in the Gunnison River. No razorback sucker or bonytail were captured or sighted during this study. A small enclave population of adult Colorado squawfish still occurs in the Gunnison River upstream of Redlands Diversion Dam. A total of five adult Colorado squawfish was collected upstream of the Dam in 1993 (Table 1) and were not translocated fish from downstream. No Colorado squawfish were captured in 1992. Eight adult Colorado squawfish were captured in the 2.3-mile stream reach between the Redlands Diversion Dam and the confluence with the Colorado River in 1992 and 1993. Two of these eight fish had been captured previously. No coded-nose-wire

Table 1. Adult Colorado squawfish collected and sighted from the Gunnison River, Colorado, 1992 and 1993. Note: RM=river mile index; M=male, F=female, I=indeterminate.

Capture		Sighting	PIT Tag	Radio	Total length	Weight	
Date	RM	RM	ID	Freq.	(mm)	(g)	Sex
92/04/15	--	7.7	--	--	--	--	-
92/04/21	3.0	--	7F7D073369	--	712	3,050	I
92/06/01	2.6	--	7F7D22566A	--	762	5,230	F
92/07/16	--	32.9	--	--	--	--	-
92/07/16	--	30.8	--	--	--	--	-
92/07/27	2.8	--	7F7D164B62	--	652	2,240	F
93/03/23	3.0	--	7F7D1B7200	.110	597	2,092	F
93/03/31	0.7	--	7F7D1D6E1E	.990	700	3,068	M
93/04/09	2.1	--	7F7D224E7D	.960	901	6,560	F
93/04/09	1.1	--	7F7D074F47	.510	597	1,892	F
93/04/28	33.5	--	7F7D1B6B55	.190	630	2,080	F
93/05/03	18.2	--	7F7D1E0240	--	497	1,050	I
93/05/03	16.7	--	7F7D0F6031	.860	847	6,247	F
93/05/07	2.9	--	7F7D1E2816	.920	705	3,670	F
93/07/14	33.7	--	7F7D0F673B	--	597	1,980	M
93/07/14	33.7	--	7F7D134743	--	613	2,370	M
93/10/05	--	48.4	--	--	--	--	-

tags were detected in any of the Colorado squawfish captured either up- or downstream of the dam during this study. This indicated that none of the fish captured in this study were recruited from those stocked in the Gunnison River in 1984.

The reach between Bridgeport and Escalante Bridge was heavily used by adult Colorado squawfish and may be an important area for this species. Three fish captured during this study were found within a 0.2-rm reach (rm 33.5 to 33.7). Two fish were males captured almost simultaneously in a large eddy at rm 33.7 on 14 July 1993. Both of these males were tuberculate and exuding milt at the time of capture. Wick also caught ripe adult Colorado squawfish in this same general vicinity in 1982 and believed that the reach between Little Dominguez Creek (rm 30) and Peeples Orchards (rm 34) was important for Colorado squawfish (Personal communication, Edmund Wick). One female Colorado squawfish (TL=497 mm) was captured in Kannah Creek, approximately 300 ft from its confluence with the Gunnison River during rising flows on 5 May 1993. Another Colorado squawfish was captured downstream at rm 16.7 on the same day. Four other fish were positively sighted but not captured during the 2-year study (Table 1).

Valdez et al. (1982a) captured four adult Colorado squawfish in 1980 and 1981 upstream of Redlands Diversion Dam in the same general vicinity (rm 26.7 to 33.8) where squawfish were captured in 1993 (Appendix G; Table G-1). Valdez et al. (1982a) also reported that four additional adult squawfish were observed but not captured between rm 22.1 and 31.4 during their study in 1980 and 1981. One humpback chub (TL=255 mm) was captured in a deep eddy-pool within a canyon-bound reach at rm 22.0 in 1993 (Appendix I; Table I.11.). This is the first known photo-documented capture of a humpback chub from the Gunnison River.

Distribution and Abundance of Fishes

A total of 196.6 river miles were sampled with electrofishing between April and October in 1992 with a total effort of 78.18 hours (Table 2). In 1993, 172 river miles were sampled between April and October with a total effort of 65.38 hours (Table 2). In 1992, a total of 21,364 fish representing 5 orders, 8 families, 21 species, and 3 hybrids were obtained from 193 samples by electrofishing (Appendix A; Table A-1). In 1993, a total of 13,260 fish were obtained from 150 samples. The number of fish, the percentage composition, ranked CPUE, and the frequency of occurrence of all fishes collected by electrofishing during 1992 and 1993, by reach, are provided in Appendix E; Tables E-1 to E-8 and Appendix F; Tables F-1 to F-8. Numerically, the eight most common fishes collected by electrofishing in descending order were bluehead sucker (36%), flannelmouth sucker (29%), roundtail chub (14%), common carp (7%), white sucker (6%), brown trout (3%), rainbow trout (2%), and white sucker X bluehead sucker hybrid cross (1%)(Figure 5). These eight species accounted for 98% of the total fish caught by electrofishing.

The Gunnison River still contains healthy populations of native fishes. Seven native species, 14 nonnative species, and 3 hybrids were collected in 1992 and 1993. Although only seven native species were collected, they comprised 79% of the total number (34,985) of all fishes collected by electrofishing in 1992 and 1993 (Figure 6). Spring flows were about three times higher in 1993 than

Table 2. Catch statistics for fishes collected by electrofishing from the Colorado River confluence to the North Fork confluence, Gunnison River, Colorado, 1992 and 1993. Note: rotation and reach data were pooled. See Appendices E, F, and H; Tables E-1 to E-8, F-1 to F-8, and Figures H-1 to H-14 for data by specific reach, year, size class of fish, and fish species.

Reaches 1-7 (River Mile: 0.7-74.9)

Common Name	Number of Fish		Percentage Composition[a]		CPUE[b] (Fish/Hour)		Ranked CPUE		Frequency of Occurrence in Samples[c]	
	'92	'93	'92	'93	'92	'93	'92	'93	'92	'93
rainbow trout	462	315	2.16	2.31	5.87	4.82	7	9	78	41
brown trout	454	424	2.12	3.11	5.77	6.44	6	7	119	93
northern pike	9	5	0.04	0.04	0.11	7.64	15	6	7	5
common carp	1,365	1,087	6.39	7.98	17.33	16.63	4	4	157	110
roundtail chub	3,070	1,988	14.37	14.60	38.98	30.41	3	3	174	134
humpback chub	0	1	–	< 0.01	–	0.01	–	17	–	1
Colorado squawfish	3	6	0.01	0.04	0.04	0.09	16	13	3	5
speckled dace	153	63	0.72	0.46	1.94	0.96	9	11	76	27
longnose sucker	1	0	< 0.01	–	0.01	–	17	–	1	0
white sucker	1,411	718	6.60	5.27	17.92	10.98	5	5	141	100
bluehead sucker	7,928	4,547	37.11	33.38	100.67	69.54	1	1	184	138
flannelmouth sucker	6,156	3,869	28.81	28.41	78.17	59.17	2	2	189	145
razorback sucker	0	0	–	–	–	–	–	–	0	0
black bullhead	9	2	0.04	0.01	0.11	0.02	15	15	7	1
channel catfish	21	1	0.10	0.01	0.27	0.02	11	15	10	1
green sunfish	15	6	0.07	0.04	0.19	0.09	13	13	9	4
smallmouth bass	1	0	< 0.01	–	0.01	–	17	–	1	0
largemouth bass	0	1	–	0.01	–	0.02	–	15	0	1
mottled sculpin	18	4	0.08	0.03	0.23	0.06	12	14	13	4
Hybrids										
bluehead sucker X flannelmouth sucker	12	13	0.06	0.10	0.15	0.20	14	12	8	12
white sucker X bluehead sucker	178	316	0.83	2.32	2.26	4.83	8	8	67	64
white sucker X flannelmouth sucker	98	255	0.46	1.87	1.90	3.90	10	10	49	75
TOTAL	21,364	13,621	100.0	100.0	–	–	–	–	–	–

[a] Percent of the total number of juvenile plus adult fishes in reaches 1-7.

[b] CPUE (total catch per unit of effort) in reaches 1-7.

[c] Number of samples: 1992: 193; % native fishes: 79.24; % non-native fishes: 20.76.
: 1993: 150; % native fishes: 78.06; % non-native fishes: 21.94.
Total hours sampled: 1992: 78.182.
: 1993: 65.383.
Total river miles sampled: 1992: 195.6.
: 1993: 172.0.

1992. Juveniles and adults of the larger-sized fishes were not influenced by the high spring flows compared to the smaller minnow species (see section on hand net and seining collections). Relative abundance for juvenile and adult fishes was nearly identical in both years. However, CPUE was slightly lower in 1993 for both native (160.2 F/h) and nonnative fishes (45.0 F/h) than CPUE in 1992 (native: 219.8 F/h; nonnative: 57.6 F/h; Figure 6). Using relative abundance as a index, the native fish assemblage in the Gunnison River has not changed in 11 years, from 1981 to 1993. Valdez et al. (1982a), who sampled the lower Gunnison River between the confluence of the Colorado River upstream to Escalante Bridge between 1979 and 1981 with electrofishing, found that 73% of all juvenile and adult fishes captured by electrofishing were native species, similar to that reported in this study. In that study, the three most common fishes collected were bluehead sucker, roundtail chub, and flannelmouth sucker. During this study Reach 4 had the highest percentage (92%) of native fishes followed by Reaches 3 and 2 (90%)(Table 3).

Table 3. Percentage of native and nonnative fishes collected by electrofishing from the seven stream reaches of the Gunnison River, Colorado, 1992 and 1993.

Stream Reach	1992		1993	
	% Native	% Nonnative	% Native	% Nonnative
1	75	25	81	19
2	92	8	88	12
3	91	9	89	11
4	94	6	90	10
5	80	20	81	19
6	54	46	47	53
7	50	50	31	69

Common carp (7%) and white sucker (6%) were the most frequent nonnative fishes encountered in the seven study reaches. Both species were found in all seven reaches. Only one adult channel catfish (TL=644 mm) was caught upstream of the Redlands Diversion Dam (rm 17). Although CDOW stocked channel catfish in the lower Gunnison River in 1964 and 1965 (Kidd 1977), only twenty-one channel catfish were captured in the 2.3-mile reach between the Redlands Diversion Dam and confluence with the Colorado River during 1992 and 1993. Twenty northern pike were caught in 1992 and 1993; 13 of which were captured in a 0.9-mile reach immediately downstream of Hartland Diversion Dam (Table 4). Two male northern pike were captured in trap nets in an oxbow at rm 53.9 in June 1993. Northern pike were not stocked in the Gunnison River but are most likely downstream migrants from Paonia Reservoir which was stocked by CDOW in 1969 and 1970 (Wiltzius 1978). Other nonnative fishes caught infrequently by electrofishing included green sunfish (0.06%) and black bullhead (0.03%). Six of ten black bullhead were captured in Reach 1 and 13 of 18 green sunfish were captured in Reach 5. Single specimens of smallmouth and largemouth bass were caught in the Redlands Diversion Dam plunge pool. Approximately 1,800 fingerling smallmouth bass were stocked by the CDOW near Delta in 1973 (Wiltzius 1978), but they

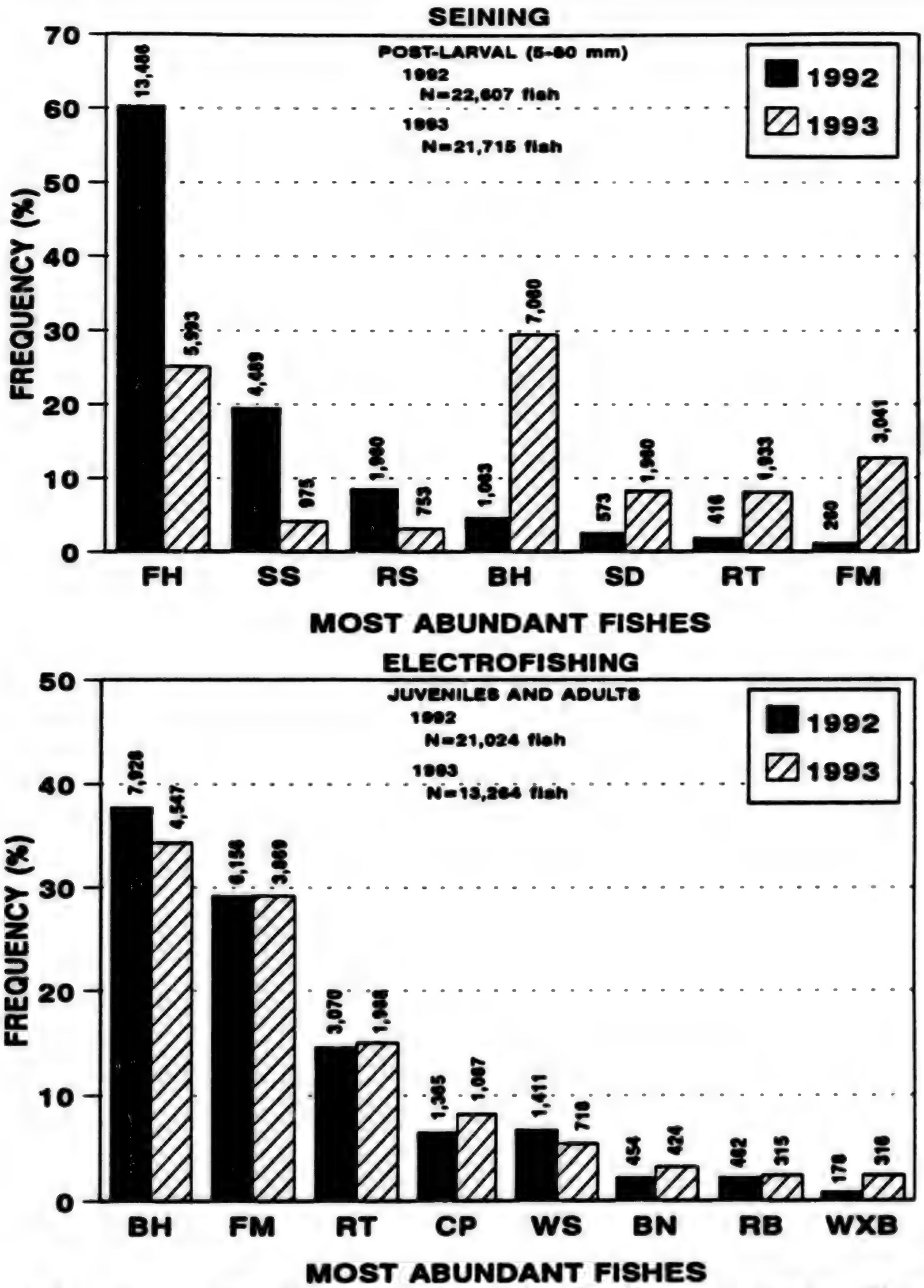


Figure 5. Comparison of percent composition for the most abundant fishes collected in the Gunnison River, Colorado, 1992 and 1993. Data for both reaches and sampling dates were pooled; numbers above bars represent numbers of fish. Most of the species collected by seining were young-of-the-year and most of the species collected by elecrofishing were juveniles and adults. Non-native minnow species (FH, SS, and RS) were too small to be collected by electrofishing--young-of-the-year and adults of these species were both collected with seines. Refer to Appendix A; Table A-1 for the two-letter species codes.

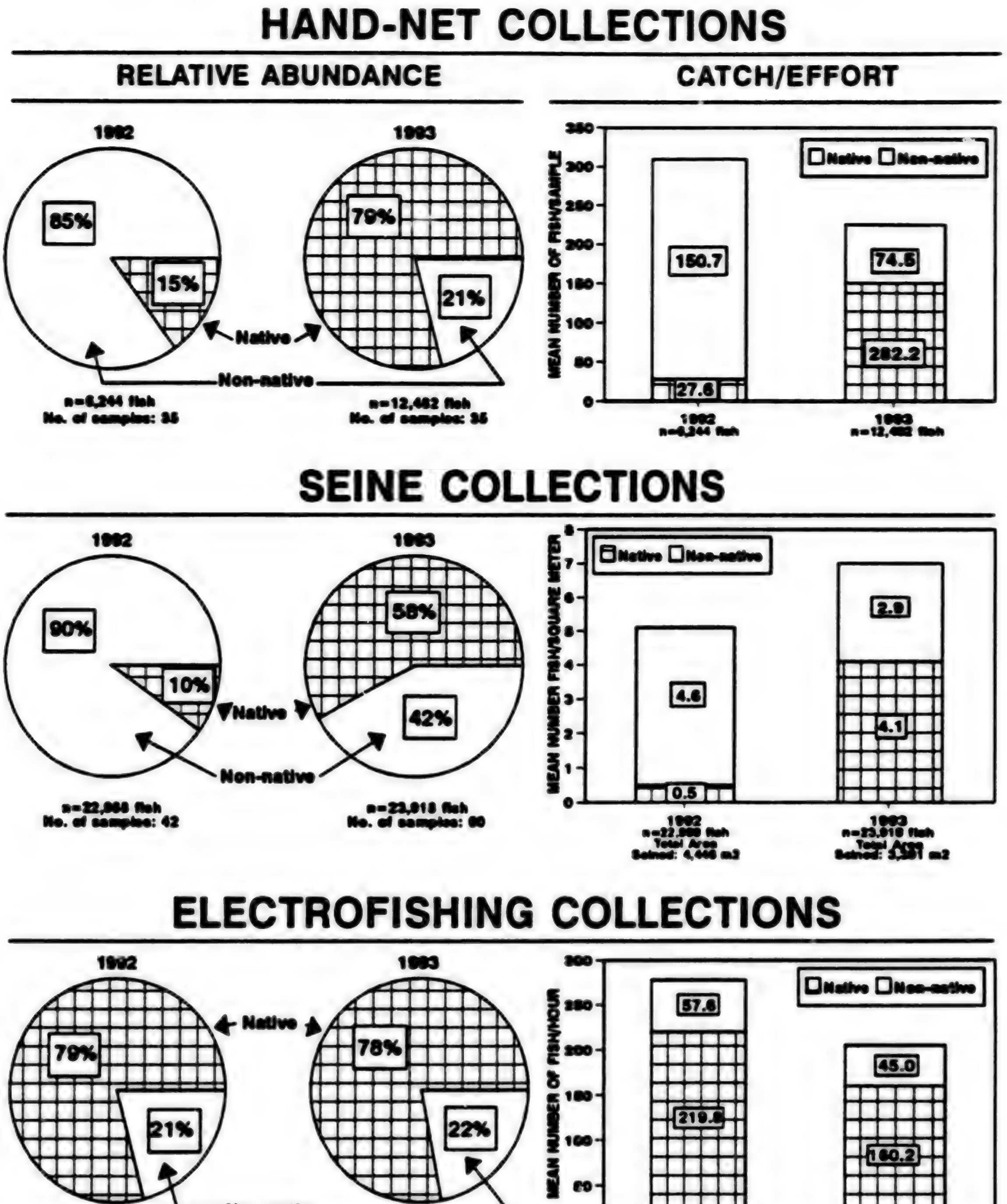


Figure 6. Comparison of relative abundance and catch per unit effort for native and nonnative fishes collected from the Gunnison River, Colorado, 1992 and 1993, with 3 different gear types: hand nets, seines, and electrofishing. Hand nets were used primarily to collect larval fishes; seines were used to collect post-larval fishes, and electrofishing was used primarily to collect juvenile and adult fishes. Data for both reaches and sampling dates were pooled.

apparently have not become established in the Gunnison River. One juvenile longnose sucker was collected from Reach 6.

Table 4. Adult northern pike collected from the Gunnison River, Colorado, 1992 and 1993. Note: RM=river mile index; M=male, F=female, I=indeterminate..

Capture		PIT Tag ID	Total length (mm)	Weight (g)	Sex
Date	RM				
92/04/21	3.0	--	915	5,424	I
92/04/24	58.1	--	630	--	I
92/06/03	59.4	--	578	--	I
92/07/30	59.3	--	757	--	I
92/07/30	59.3	--	691	--	I
92/07/30	59.3	--	706	--	I
92/07/30	59.3	--	545	--	I
92/07/30	59.3	--	589	--	I
92/09/08	59.4	7F7D102210	738	--	I
93/03/23	3.0	7F7D173360	590	1,294	M
93/05/13	59.4	7F7D0F741C	686	2,650	I
93/05/14	65.2	7F7D10111F	757	4,600	I
93/05/20	53.9	7F7D0F3D59	545	1,220	M
93/05/25	53.9	7F7D165B0D	725	2,625	M
93/06/30	59.3	--	749	2,850	I
93/07/06	73.2	7F7D101237	400	590	I
93/09/28	65.0	7F7D172E11	610	1,475	I
93/09/29	58.5	7F7D140739	835	3,750	I
93/11/23	59.8	7F7D072A5B	794	3,200	I
93/11/23	59.3	7F7D07321E	784	3,400	I

Reach 6 and 7 contained the highest percentage (60%) of nonnative fishes because of the large numbers of rainbow and brown trout captured in these two reaches (Table 3). Seventy-four percent of 1,655 rainbow and brown trout sampled were caught upstream of Hartland Diversion (rm 59.5). The percentage of three nonnative fish, white sucker (16.4%), rainbow trout (11.5%) and brown trout (12.3%), were dramatically greater in Reaches 6 and 7 than downstream in Reaches 1 through 5 (Figure 7).

The percentage of nonnative fishes collected in the 2.3-mile reach downstream of the Redlands Diversion Dam was qualitatively not different than that of the three reaches upstream of the diversion dam. This was surprising because nonnative fishes such as channel catfish can freely access this reach from the Colorado River (Figure 7).

Bluehead sucker were most abundant in Reach 5 (CPUE=146 F/h) in both 1992 and 1993 (Figure 8). Flannelmouth sucker were most abundant in Reach 1 (131 F/h). Upstream of Redlands Diversion Dam, flannelmouth sucker were most abundant in Reach 5 (96 F/h). Roundtail chub were most abundant in Reaches 2 (57 F/h) and 3 (49 F/h). Only 58 roundtail chub (1%) were collected upstream of Hartland

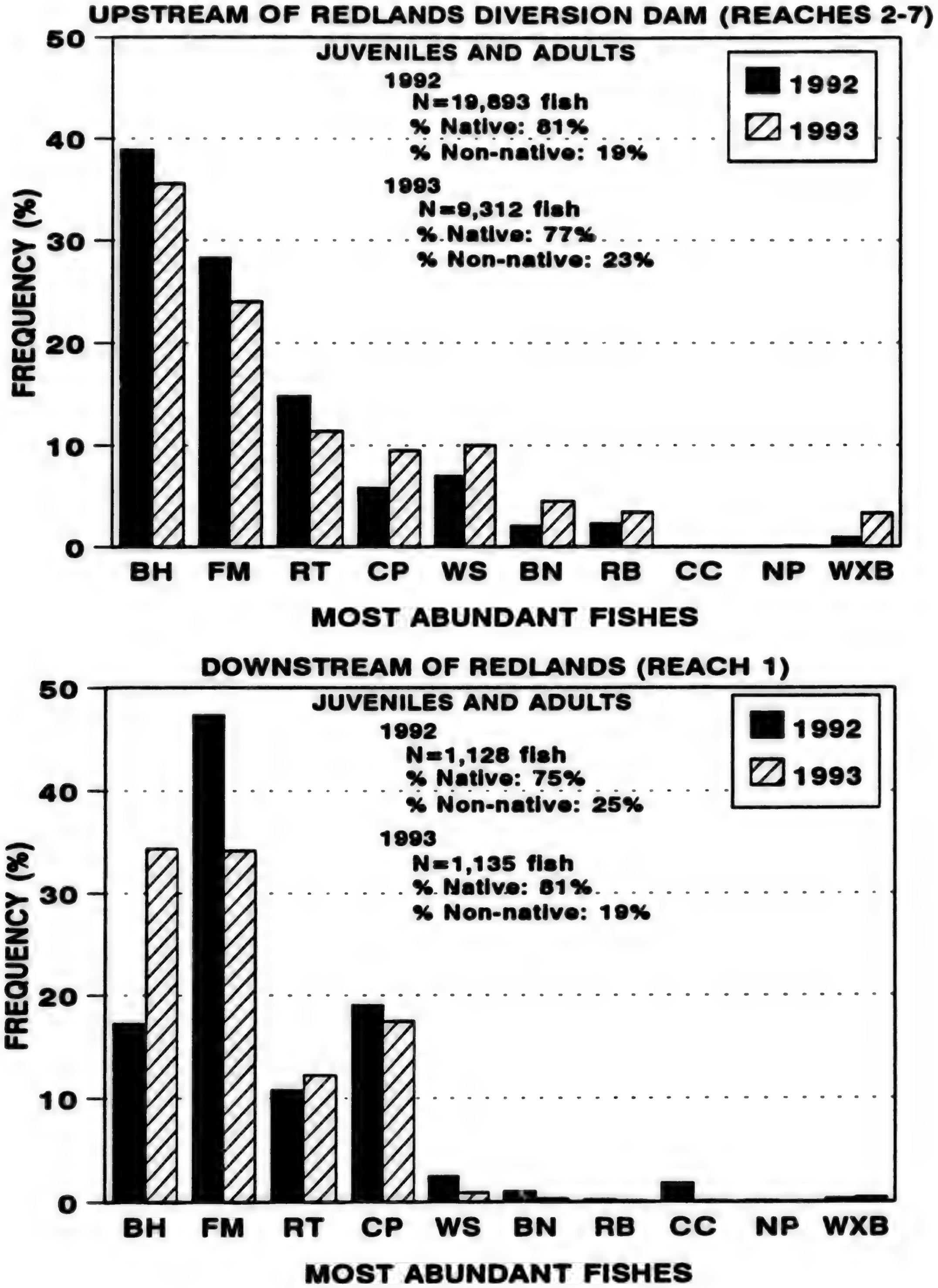


Figure 7. Comparison between the relative abundance of juvenile and adult native and nonnative juvenile and adult fishes and percent composition for the 10 most abundant juvenile and adult fishes collected by electrofishing in the Gunnison River upstream and downstream of Redlands Diversion Dam, 1992 and 1993. Data for sampling dates were pooled. Refer to Appendix A; Table A-1 for the two-letter species codes.

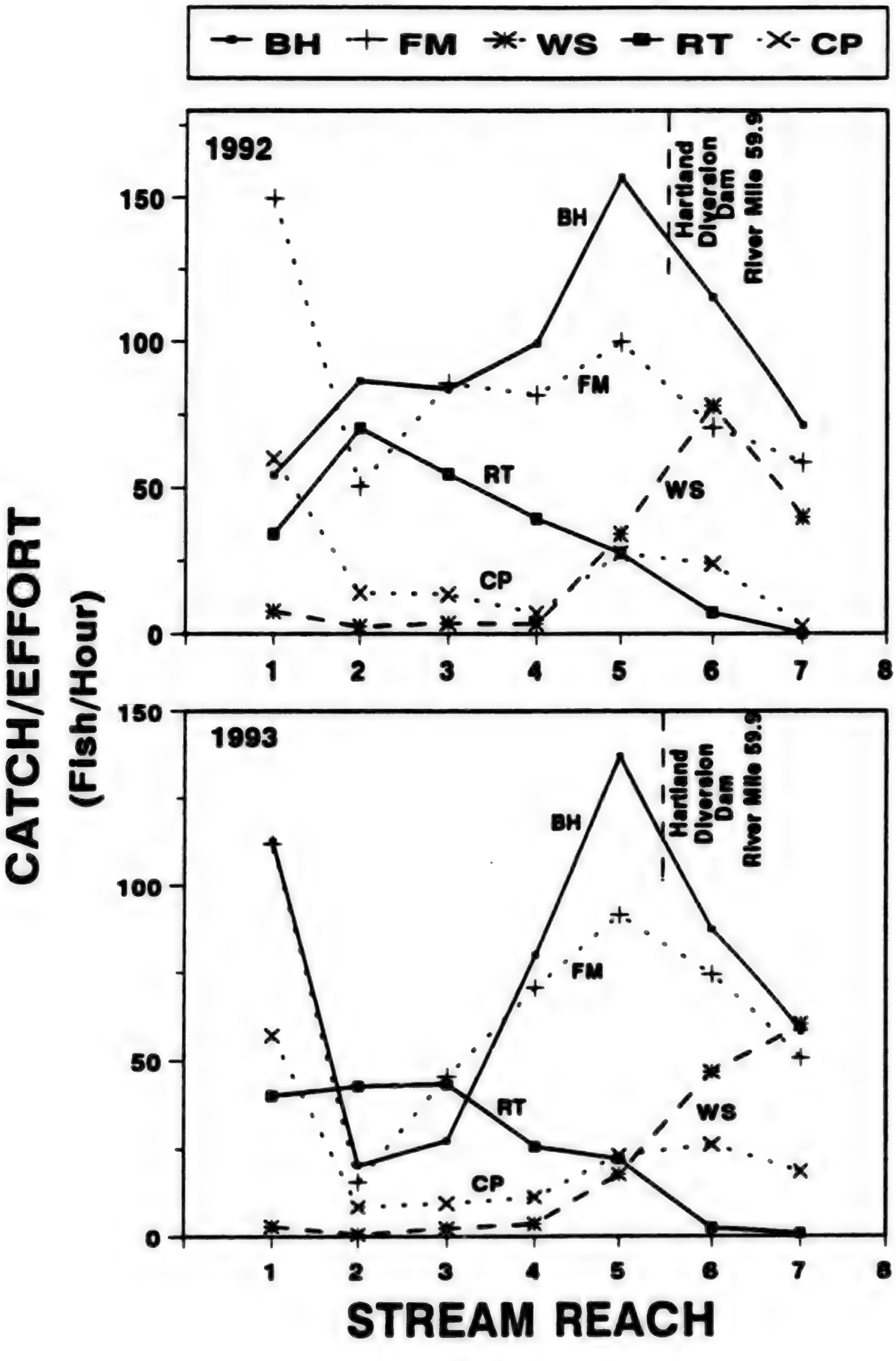


Figure 8. Total catch per unit effort (total number of fish divided by total effort [hour])(Fish/h) by reach for the five commonest fish species collected by electrofishing in the Gunnison River, Colorado, 1992 and 1993: bluehead sucker (BH), flannelmouth sucker (FM), white sucker (WS), roundtail chub (RT), and carp (CP).

Diversion Dam in Reaches 6 and 7. Common carp were most abundant in Reach 1 (59 F/h). White sucker CPUE was highest in Reach 6 (64 F/h) followed by Reach 5 (27 F/h).

Hybridization of the nonnative white sucker with both the native bluehead and flannelmouth sucker was observed in this study. White suckers hybridized with bluehead suckers (CPUE=3.44 F/h) more than flannelmouth suckers (2.46 F/h; Table 2). Because white suckers were most numerous in Reaches 6 and 7, it is understandable that most hybrid suckers were also caught in these reaches. CPUE for white x bluehead crosses was 20 F/h in Reaches 6 and 7 combined; CPUE for white x flannelmouth crosses for these same two reaches was 12 F/h (Figure 9). Only 15 bluehead x flannelmouth hybrids were observed in this study (Table 2). Wiltzius (1978) reported that the three hybrid sucker crosses described above as well as hybrid crosses between longnose sucker and bluehead and longnose and flannelmouth also occurred in the Gunnison River. Longnose sucker commonly occur in the Uncompahgre River (Personal communication, Dave Langlois), a tributary of the Gunnison River (Figures 1 and 3).

Hybridization between native Colorado River catostomids and also with nonnative catostomids has been observed in nature throughout the Colorado River basin for almost 100 years (Jordan 1891; Vanicek et al. 1970; Holden and Stalnaker 1975; McAda and Wydoski 1980; Carothers and Minckley 1981; Buth et al. 1987), but the rate of hybridization reported in these accounts appears to be low. However, it is difficult to determine whether the incidence of hybridization in the Gunnison River has increased or decreased during this period. The reaches near Delta have been identified as a re-introduction area for razorback sucker (Burdick 1992). Compared to other reaches in the Upper Colorado River, the Gunnison River has relatively low densities of piscivorous, nonnative fishes--a positive factor for re-introduction of razorback sucker. These same reaches, however, also have the highest numbers of white sucker and white sucker hybrids. Although it is unknown if white sucker will hybridize with razorback sucker, the obvious negative consequences of hybridization is that the integrity of the razorback sucker genome would be compromised and restoration efforts for this endangered species in the Gunnison River could be jeopardized. Fish populations in these reaches should be monitored and re-introduction programs conducted to detect whether a significant increase in catostomid hybridization occurs.

CPUE was compared for four native and two nonnative juvenile and adult fishes collected by electrofishing in reaches where sampling was similar to former studies (Valdez et al. 1982a; Wick et al. 1985): reaches 2, 3, and 4. No sampling was conducted between 1982 and 1992. CPUE for bluehead sucker, flannelmouth sucker, roundtail chub, and carp were noticeably higher in 1982 than in either 1981, 1992, or 1993. Worth noting was the dramatic increase in white sucker abundance. CPUE for this species, which is distributing itself downstream in both the Gunnison and Colorado rivers, increased three-fold (3.2 F/h) in Reaches 2, 3, and 4 over the past 11 years (Figure 10). CPUE for juvenile and adult Colorado squawfish collected upstream of Redlands Diversion Dam declined during the past 11 years.

CPUE estimates for juvenile and adult fishes collected by electrofishing during 1992 and 1993, by reach and by rotation, are summarized in Appendix H;

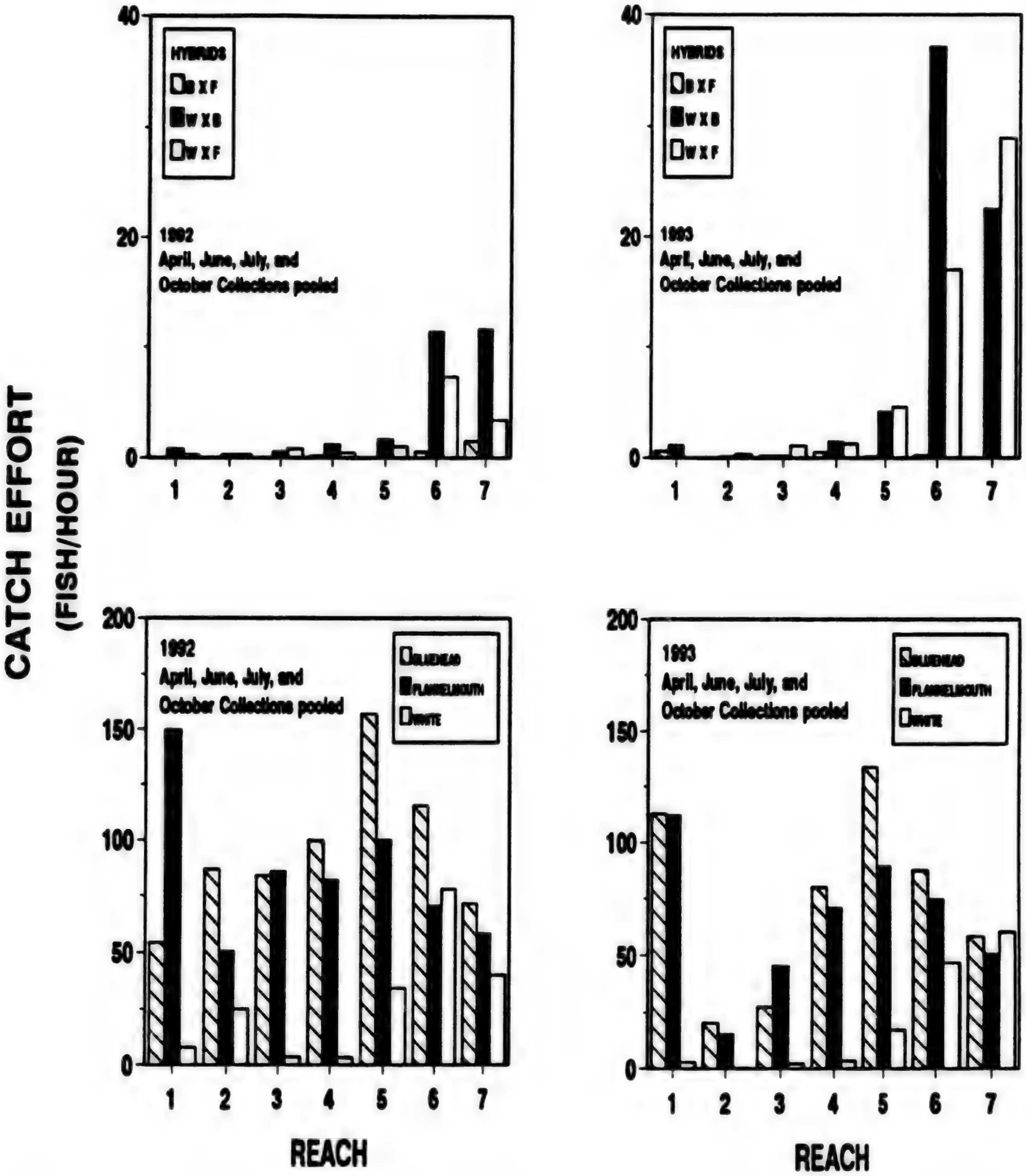


Figure 9. Catch effort (total number of fish divided by total effort [hour]) by reach for bluehead sucker, flannelmouth sucker, and white sucker (bottom) compared with catch effort for hybrid suckers (bluehead x flannelmouth [BXF]; white x bluehead [WxB]; white x flannelmouth [WxF])(top), Gunnison River, Colorado, 1992 and 1993. Note: fish collection data for sampling dates were pooled; electrofishing was the sampling gear.

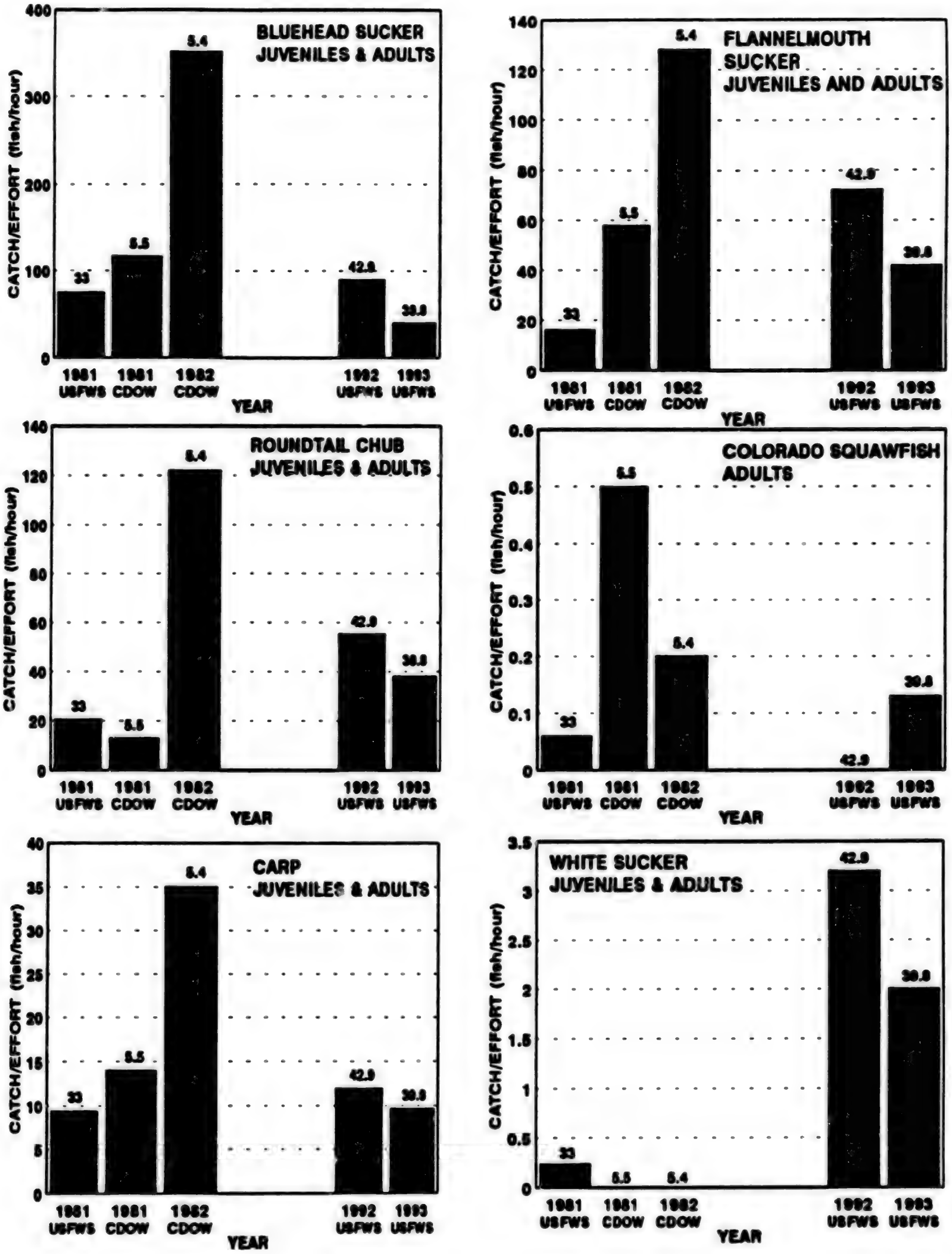


Figure 10. Catch effort (fish/hour) for four native and two nonnative fishes collected by electrofishing in Reaches 2, 3, and 4 (river mile 3.9-42.0) of the Gunnison River, Colorado, 1981, 1982, 1992, and 1993. USFWS 1981 (Valdez et al. 1981), CDOW 1981 and CDOW 1982 (Wick et al. 1985), USFWS 1992 and USFWS 1993 (this study). Juvenile and adult fish include specimens ≥ 100 mm; numbers above bars represent hours electrofished.

Tables H-1 to H-14.

Size Structure of Common Fishes

More juvenile (56%) than adult bluehead sucker were collected riverwide in 1992 (Appendix E; Table E.1.). The reverse was observed in 1993, adult fish comprised 64% (Appendix F; Table F.1.) of the catch. The largest bluehead sucker were collected from Reaches 6 and 7. The mean length for bluehead sucker collected from Reach 6 was 357 mm and 370 mm and Reach 7 was 368 mm and 378 mm in 1992 and 1993, respectively (Figure 11; Appendix I; Tables I.1. and I.4; Figures I.1 and I.4.). The smallest bluehead sucker collected were from Reaches 2 (mean, 253 mm) and 3 (mean, 260 mm; Appendix I; Tables I.1 and I.4; Figures I-1 and I.4).

More juvenile (57%) than adult flannelmouth sucker were collected riverwide in 1992 (Appendix E; Table E.1.) but about equal numbers of juvenile and adult fish were collected in 1993 (Appendix F; Table F.1). The largest flannelmouth sucker were collected from Reaches 6 and 7. The mean length for flannelmouth sucker collected from Reach 6 was 440 mm and 463 mm and Reach 7 was 467 mm and 480 mm in 1992 and 1993, respectively (Figure 12; Appendix I; Tables I.2 and I.5.; Figures I.2 and I.5.). Mean length for flannelmouth sucker in Reaches 1-4 was similar in 1992 and 1993 (Reach 1, 362 mm; Reach 2, 367 mm; Reach 3, 370 mm; Reach 4, 381 mm; Appendix I; Tables I.2 and I.5).

More juvenile (59%) than adult roundtail chub were collected riverwide in 1992 (Appendix E; Table E.1.) but approximately equal numbers of juvenile and adult fish were collected in 1993 (Appendix F; Table F.1.) The largest roundtail chub were collected from Reach 4 (mean, 305 mm). Mean length was similar for Reaches 1-3 (mean, 281 mm, 260 mm, 261 mm, respectively) and Reach 5 (mean, 273 mm; Figure 13; Appendix I; Tables I.3. and I.6.; Figures I.3 and I.6). The smallest roundtail chub were collected from Reach 6 (mean, 205 mm), although the sample size (n=31) was small in this reach (Appendix I; Tables I.3 and I.6.).

Length- and weight-frequency distributions were determined for both rainbow and brown trout (Appendix I; Figure I.7.). Mean length of rainbow (324 mm) and brown trout (290 mm) collected from the warmwater reaches (1-5) of the Gunnison River was not significantly smaller than fish collected from the traditional "trout" reaches (6 and 7; RB=333 mm, BN=285 mm)(Appendix I; Table I.7.).

Only large northern pike were captured in the Gunnison River. Mean length of northern pike was 683 mm in 1992 and 680 mm in 1993 (Appendix I; Tables I.10-11.). The smallest northern pike, TL=400 mm, was captured at rm 73.2 in 1993 (Table 3). The length distribution of captured fish suggests that northern pike are not reproducing in the Gunnison River, and that they are still escaping from Paonia Reservoir upstream. Wiltzius (1978) reported that northern pike captured from the Gunnison River in the 1970's were all large, adult-size fish and believed the fish originated from Paonia Reservoir and migrated downstream in the North Fork of the Gunnison River.

White sucker mean length did not vary by reach, rotation, or year during the study (Figure 14; Appendix I; Tables I.8 and I.9). The mean TL was 347 mm

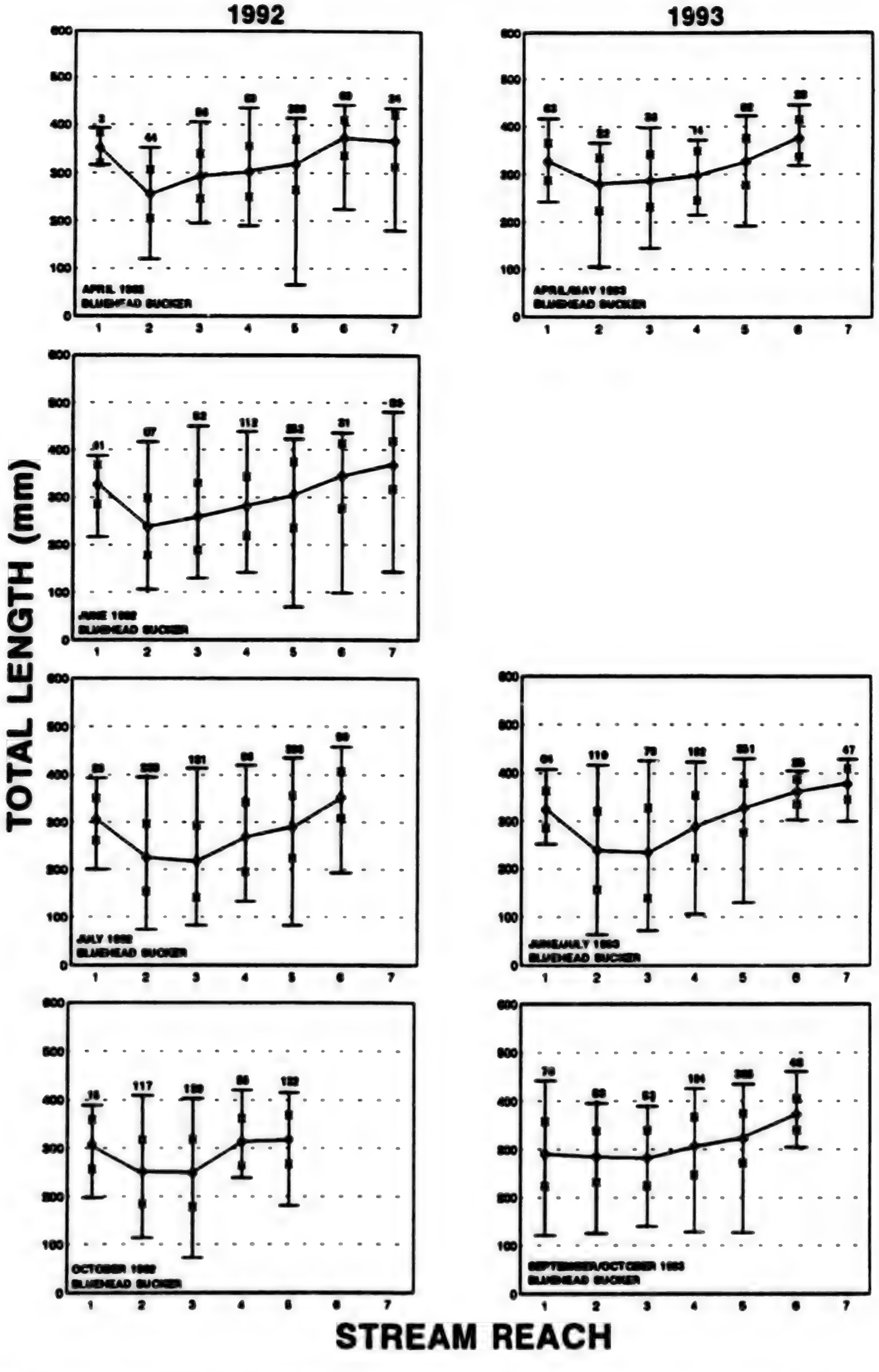


Figure 11. Comparison of mean total length (mm) for bluehead sucker collected in 1992 and 1993 by electrofishing from seven stream reaches of the Gunnison River, Colorado. Solid lines connect the means (+), asterisks represent one standard deviation, and error bars (┬,┴) represent the range. Numbers above the error bars represent sample sizes.

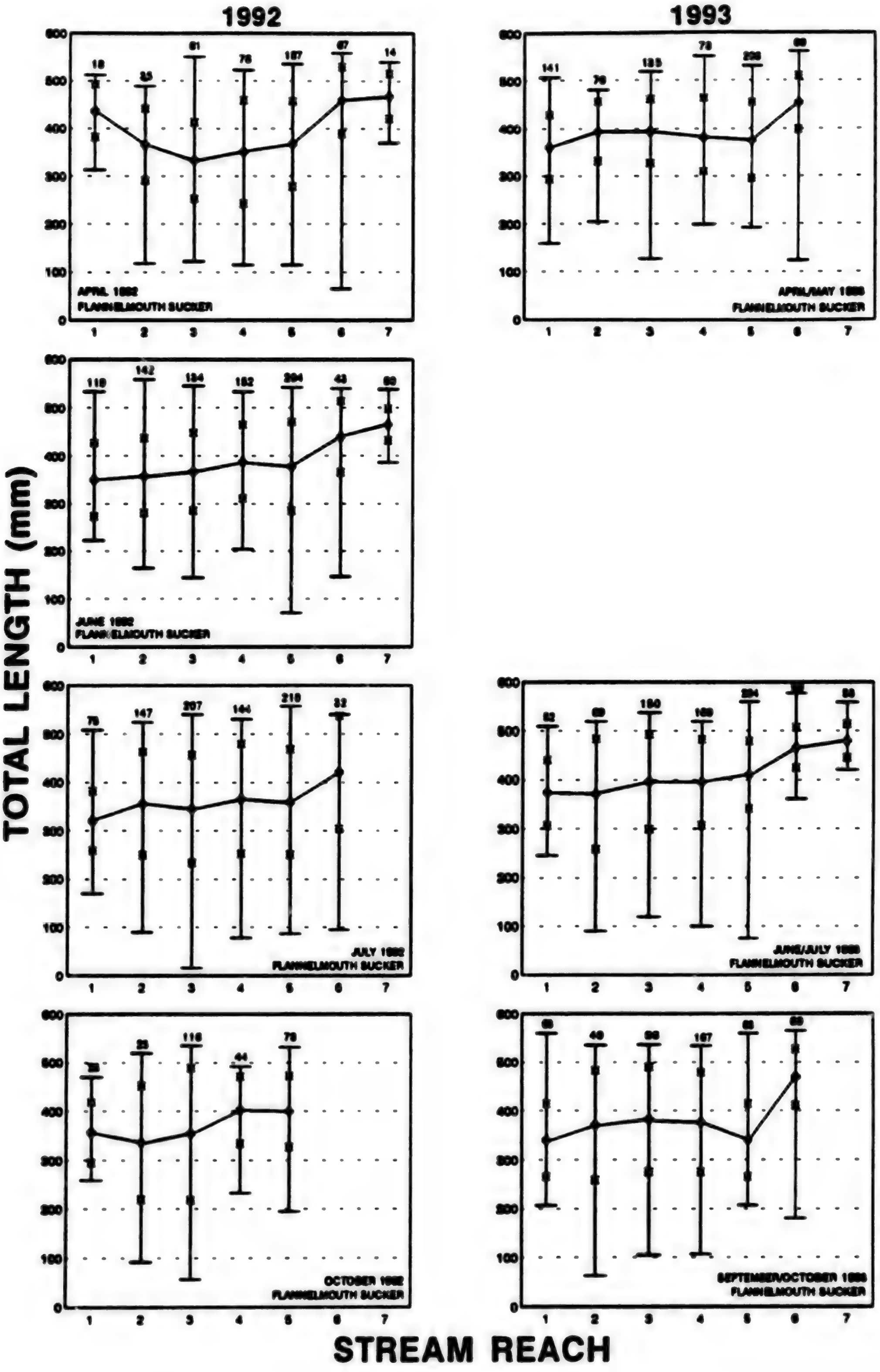


Figure 12. Comparison of mean total length (mm) for flannelmouth sucker collected in 1992 and 1993 by electro- fishing from seven stream reaches of the Gunnison River, Colorado. Solid lines connect the means (┼), asterisks represent one standard deviation, and error bars (┬,┴) represent the range. Numbers above the error bars represent sample sizes.

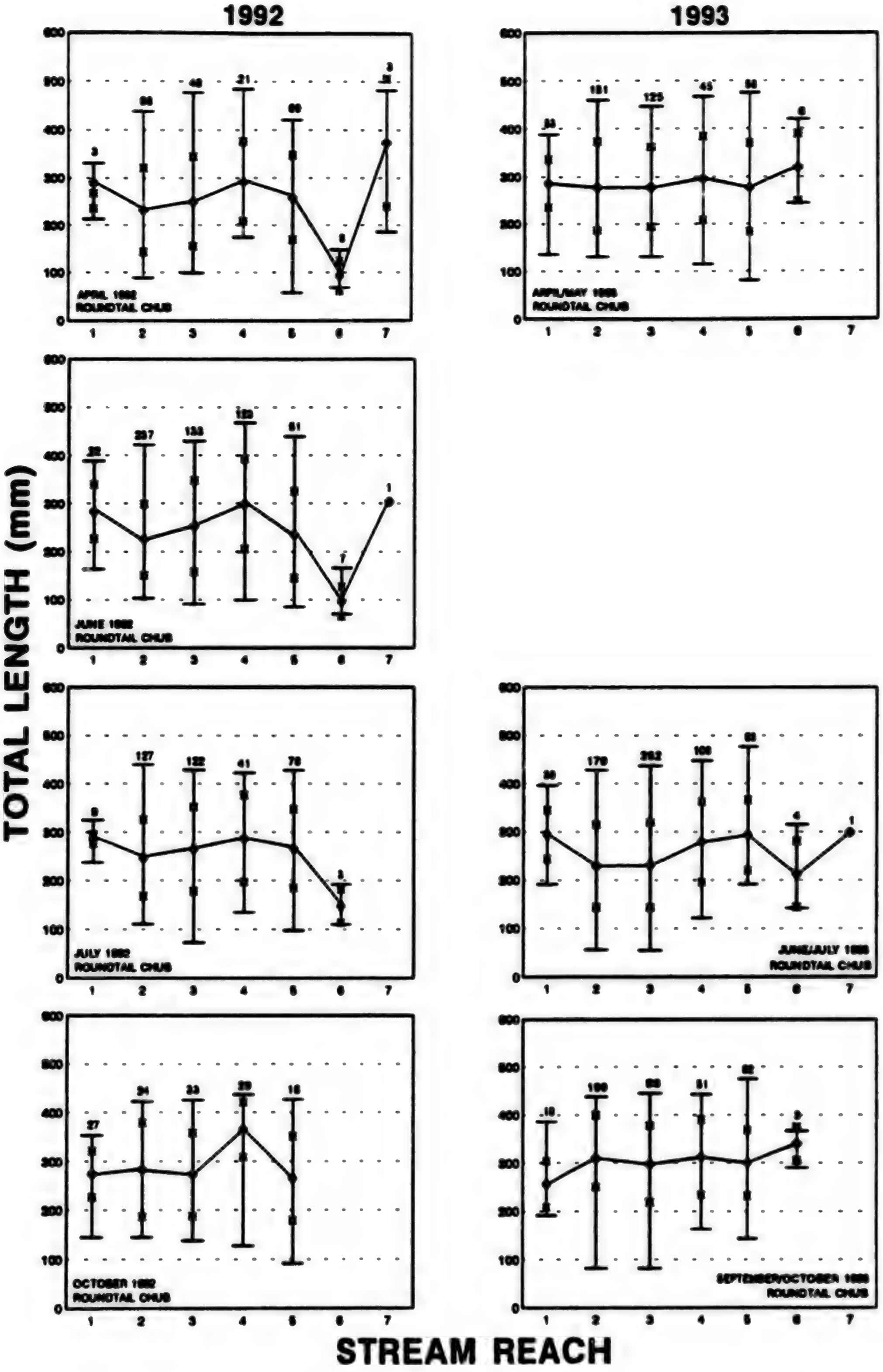


Figure 13. Comparison of mean total length (mm) for roundtail chub collected in 1992 and 1993 by electrofishing from seven stream reaches of the Gunnison River, Colorado. Solid lines connect the means (┼), asterisks represent one standard deviation, and error bars (┬,┴) represent the range. Numbers above the error bars represent sample sizes.

and 351 mm in 1992 and 1993, respectively, for all reaches and rotations combined. Length- and weight-frequency distributions are summarized in Appendix I; Figure I.8. for white sucker and carp collected during 1992.

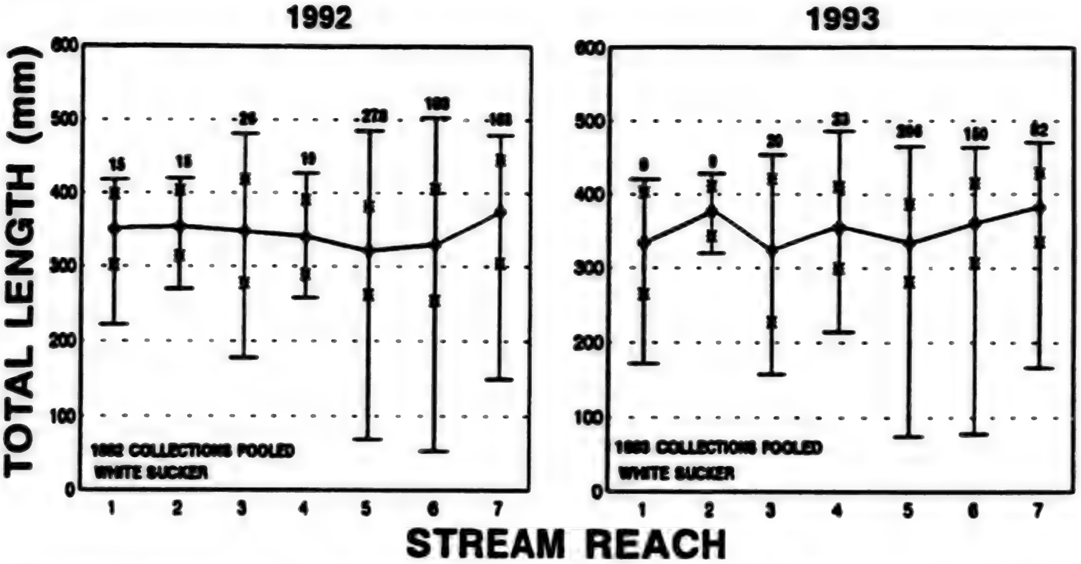


Figure 14. Comparison of mean total length (mm) for white sucker collected in 1992 and 1993 by electrofishing from seven stream reaches of the Gunnison River, Colorado. Solid lines connect the means (┼), asterisks represent one standard deviation, and error bars (┬,┴) represent the range. Numbers above the error bars represent sample sizes.

Hand-Net Collections

Distribution and Abundance of Common Fishes

A total of 35 samples representing 11 species, unidentified minnows, and unidentified suckers were collected in each of August 1992 and 1993. The collections contained 6,241 fish in 1992 and 12,482 fish in 1993 (Table 5). All fish caught by hand-nets were YOY and most of these were larval fish. No Colorado squawfish or "obvious" razorback sucker were identified in either year (Personal communication, Darrel Snyder). The larval fish community structure of the Gunnison River was much different in 1993 than that of 1992. In 1992, nonnative fish comprised 85% of the total number of fishes collected. Numerically, the six most common species collected in descending order were fathead minnow (67.4%), sand shiner (8.0%), red shiner (7.4%), roundtail chub (6.1%), bluehead sucker (6.0%), and speckled dace (3.0%; Table 5). These species accounted for 97.9% of the total fishes caught with hand-held seines in 1992. In 1993, native fishes were more numerous, comprising 79% of the total number of fish in samples. Numerically, the six most common species were bluehead sucker (34.5%), roundtail chub (22.1%), fathead minnow (13.0%), flannelmouth sucker (11.5%), speckled dace (11.1%), and white sucker (6.0%). These species accounted

Table 5. Relative abundance and number of fishes collected with hand nets from Reaches 2, 3, 4, and 5, August 1992 and 1993. Note: Fish length ranged from 1-80 mm. See Appendix J; Tables J-1 to J-10 for data by reach, 5-mm length classes, and year.

	1992[a]			1993[b]		
Species	Total	Mean No. Fish per Sample	Percent Composition	Total	Mean No. Fish per Sample	Percent Composition
Native						
roundtail chub	382	10.9	6.12	2,755	78.7	22.07
speckled dace	186	5.3	2.98	1,379	39.4	11.05
bluehead sucker	377	10.8	6.04	4,303	122.9	34.47
flannelmouth sucker	22	0.6	0.35	1,439	41.1	11.53
Nonnative						
red shiner	459	13.1	7.35	21	0.6	0.17
carp	4	0.1	0.06	26	0.7	0.21
sand shiner	500	14.3	8.01	11	0.3	0.09
fathead minnow	4,207	120.2	67.41	1,624	46.4	13.01
longnose sucker	0	0	0	2	0.1	0.02
white sucker	21	0.6	0.34	746	21.3	5.98
plains killifish	18	0.5	0.29	1	< 0.01	0.01
Unidentified minnow	65	1.9	1.04	46	1.3	0.37
Unidentified sucker	0	0	0	129	3.7	1.03
Totals	6,241	—	100.0	12,482	—	100.0

[a] Number of samples: 35; % native fishes: 15.49; % nonnative fishes: 84.51

[b] Number of samples: 35; % native fishes: 79.12; % nonnative fishes: 20.89

for 98.1% of the total fishes collected (Table 5). The relative abundance and number of larval fishes collected by reach are summarized for 1992 (Appendix J; Tables J-1; J-3 to J-6) and 1993 (Appendix J; Tables J-2; J-7 to J-10).

Relative abundance and CPUE values for native and nonnative larval fishes were reversed in 1993 from 1992. Relative abundance and density of larval fish in 1993 were similar to the population patterns of juvenile and adult fishes collected by electrofishing during 1992 and 1993 (Figure 6). Nonnative fishes dominated the catch in 1992, a relatively low-water year. Riverwide, nonnative fishes comprised 85% of the total catch in 1992 compared with 21% in 1993. CPUE between 1992 and 1993 also reflected a major shift in small-sized native and nonnative fishes in the Gunnison River. There was a ten-fold increase in the number of native fish (282 fish/sample) collected in 1993 compared to only 28 fish/sample in 1992. CPUE for nonnative fish was reduced by about 50% in 1993 from 1992 (Figure 6).

The native species that showed a response to high spring flows were roundtail chub (11 fish/sample in 1992 versus 79 fish/sample in 1993), bluehead sucker (11 versus 123), speckled dace (5 versus 39), and flannelmouth sucker (0.6 versus 41; Table 5). Those nonnative species that showed a response to high flows in 1993 were fathead minnow (120 fish/sample in 1992 versus 46 fish/sample in 1993), red shiner (13 versus 0.6), and sand shiner (14 versus 0.3; Table 5). One notable exception was the 350-fold increase in white sucker in 1993 over 1992. A strong year-class of white sucker may have been produced in 1993 or a weak year-class was produced in 1992.

It has been hypothesized that high spring flows may be one means to reduce production of several prolific nonnative fishes that are potentially detrimental to young native species such as Colorado squawfish (Meffe 1984; Minckley and Meffe 1987; Muth and Nesler 1984; McAda and Kaeding 1991a; Osmundson and Kaeding 1991). At the same time, these high spring flows may also be important in enhancing reproductive success or survival of some native species, including Colorado squawfish (Osmundson and Kaeding 1991). Although the mechanism for this response is unknown or has yet to be identified, the data collected during both larval and post-larval sampling in the Gunnison River in 1992 and 1993 support the notion that densities of the more common nonnative fishes were reduced the summer following a high spring flow and, conversely, native fish densities increased. The magnitude of the spring runoff in the Gunnison River was moderately low in 1992 (highest day of the year at the Whitewater USGS gauge=6,360 cfs) and moderately high in 1993 (20,500 cfs; Figure 15).

Anderson (1994) also reported that the relative abundance of native species was greater at all Gunnison River larval drift-net sampling stations in 1993 compared to 1992. Valdez and Williams (1993) also observed an inverse relation between spring flow magnitude and numbers of nonnative fishes (i.e., number of nonnatives decreased during years of high spring runoff) in the Colorado and Green rivers in and near Canyonlands National Park. They also suggested that the numbers of nonnative fishes, as potential predators and competitors of natives, are likely to persist in the upper basin, with only a temporary reprieve in numbers following high spring flows.

The magnitude of spring flows in the Gunnison River in 1994 were lower than 1993 and it is unfortunate that larval or post-larval fishes were not collected to determine if nonnative fish densities would have increased following low spring flows for that year. Several continuous years of larval fish data are needed for analyses following a range of different spring flow regimes to determine the specific cause of the observed fluctuations in reproductive success among various native and nonnative fishes. As more data are collected and analyzed, meaningful and consistent patterns may be detected between native and nonnative fish densities and flow quantity and magnitude (see Figures 16 and 17).

Seining Collections

Distribution and Abundance of Common Fishes

A total of 42 samples were collected in 1992 over a total area seined of 4,446 m^2. In 1993, a total of 60 samples were collected over a total area of 3,391 m^2. The collections contained 22,988 fish in 1992 and 23,918 fish in 1993 (Table 6). Seines collected both YOY and adults of both nonnative (e.g., fathead minnow, sand shiner, red shiner, plains killifish) and native (e.g., speckled dace) minnow species. Changes in the post-larval fish community structure from 1992 to 1993 were almost a mirror image of the patterns observed for larval

Table 6. Catch statistics for fishes collected by seining from Redlands Diversion Dam to Hartland Diversion Dam, Gunnison River, Colorado, 1992 and 1993. Note: reach data were pooled. (See Figures 16 and 17 for comparison and Appendix K; Tables K.1 to K.10 for data by reach and by year.)

Reaches 2-5 (River Mile: 3.1-59.9)

Common Name	Number of Fish		Percentage Composition[a]		CPUE[b] (Fish/10m^2)		Ranked CPUE		Frequency of Occurrence in Samples[c]	
	'92	'93	'92	'93	'92	'93	'92	'93	'92	'93
northern pike	0	0	–	–	–	–	–	–	0	0
red shiner	1,960	753	8.53	3.15	4.41	2.22	3	8	32	38
common carp	9	32	0.04	0.13	0.02	0.09	10	13	6	11
roundtail chub	416	1,933	1.81	8.08	0.94	5.70	6	5	18	54
sand shiner	4,489	975	19.53	4.08	10.10	2.88	2	7	29	38
fathead minnow	13,846	5,993	60.23	25.06	31.14	17.67	1	2	35	52
Colorado squawfish	0	0	–	–	–	–	–	–	0	0
speckled dace	573	1,960	2.49	8.19	1.29	5.78	5	4	19	39
longnose sucker	0	109	–	0.46	–	0.32	–	10	0	21
white sucker	260	1,589	1.13	6.64	0.58	4.69	7	6	14	45
bluehead sucker	1,063	7,060	4.62	29.52	2.39	20.82	4	1	33	56
flannelmouth sucker	260	3,041	1.13	12.71	0.58	8.97	7	3	17	57
razorback sucker	0	0	–	–	–	–	–	–	0	0
black bullhead	1	0	< 0.01	–	< 0.01	–	12	–	1	0
channel catfish	0	0	–	–	–	–	–	–	0	0
plains killifish	66	39	0.29	0.16	0.15	0.12	8	12	6	12
green sunfish	40	99	0.17	0.41	0.09	0.29	9	11	12	16
smallmouth bass	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	–	–	–	–	–	–	0	0
Unknown hybrid suckers	5	335	0.02	1.40	0.01	0.99	11	9	4	42
TOTAL	22,988	23,918	100.0	100.0	–	–	–	–	–	–

[a] Percent of the total number of post-larval fishes in reaches 2-5.

[b] CPUE (total catch per unit of effort) in reaches 2-5.

[c] Number of samples: 1992: 42; % native fishes: 10.06; % non-native fishes: 89.94.
: 1993: 60; % native fishes: 58.51; % non-native fishes: 41.49.
Total area sampled: 1992: 4,446 m^2.
: 1993: 3,391 m^2.

fishes in each of these two years. No Colorado squawfish or "obvious" razorback sucker were observed in either year (Personal communication, Darrel Snyder). In 1992, nonnative fish collectively comprised 90% of the total number of fishes collected. The six most common species collected, in descending order, were fathead minnow (60.2%), sand shiner (19.5%), red shiner (8.5%), bluehead sucker (4.6%), speckled dace (2.5%), and roundtail chub (1.8%). These species accounted for 97.1% of the total fishes caught with seines in 1992. In 1993, native fishes comprised 58% of the total number of fish collected. Numerically, the six most common species collected were bluehead sucker (29.5%), fathead minnow (25.1%), flannelmouth sucker (12.7%), speckled dace (8.2%), roundtail chub (8.0%), and

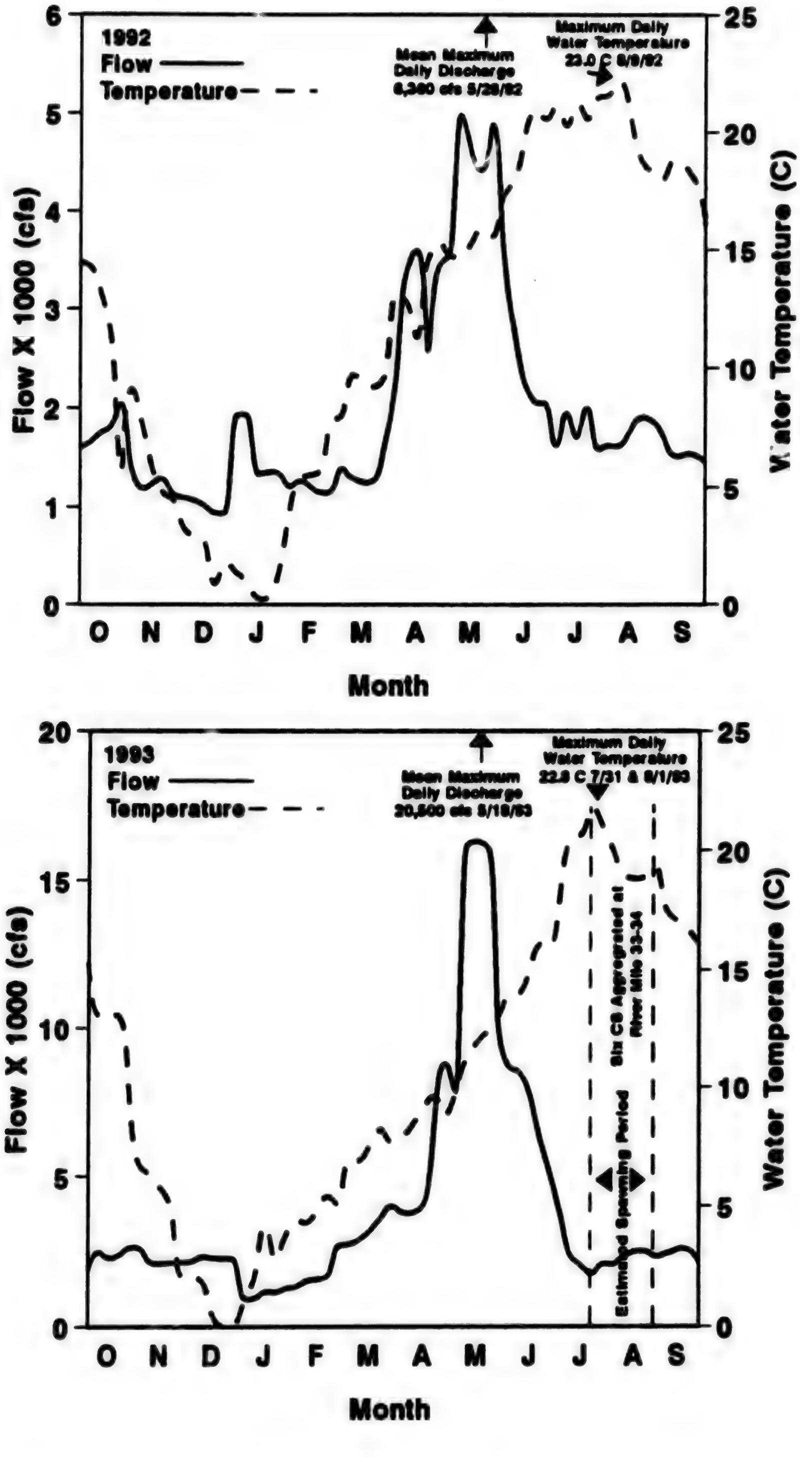


Figure 15. Discharge and mean maximum daily water temperature for the Gunnison River, 1992 and 1993, at the Whitewater USGS gauge (river mile 15). Vertical dashed lines indicate the presumed Colorado squawfish spawning period in 1993--20 July to 7 August.

ble 6). These species accounted for 90.1% of the total
93. The relative abundance, CPUE (fish/10m^2), CPUE rank,
rval fishes collected by reach are summarized for 1992
5) and 1993 (Appendix K; K-6 to K-10).

nd 1993, riverwide native fish relative abundance in seine
from 10% to 58% of the total number of fishes collected
es declined from 90% to 42%. Overall, nonnative fish CPUE
n/10m^2 to 2.9 fish/10m^2 whereas native fish CPUE increased
fish/10m^2 to 4.1 fish/10m^2 (Figure 6). The native fishes
to high flows were bluehead sucker (2.4 fish/10m^2 in 1992
in 1993), flannelmouth sucker (0.6 versus 4.7), speckled
, and roundtail chub (0.9 versus 5.7). Those nonnative
response to high spring flows in the four reaches sampled
1.1 fish/10m^2 in 1992 versus 17.7 fish/10m^2 in 1993), sand
.9), and red shiner (4.4 versus 2.2). Although fathead
uced by about 45% following the high spring flows in 1993,
most resilient of the nonnative fishes. In 1992, they
fish in Reaches 3, 4, and 5 and in 1993 they were still
in Reaches 3 and 4. White sucker YOY increased from 0.6
m^2 in 1993.

, the single cyprinodontid known to occur in the Gunnison
ant in Reach 5. Ninety-seven percent of the 105 fish
ch 5. It appears that black bullhead are not successfully
nison River. Only one YOY black bullhead was collected
Forty YOY green sunfish were collected in 1992; 99 in
rcent of the green sunfish were collected from Reach 3 in
most (75%) of the green sunfish were collected from Reach
K-10).

l for six nonnative fishes and four native fishes collected
CPUE from former studies (Figures 16 and 17). This
parisons of the fish community structure and the abundance
he Gunnison River with time. Although it is acknowledged
fluctuations in population densities of fishes from one
differences in sampling techniques among studies, the
the most numerous fishes in the Gunnison River, white
, sand shiner, and red shiner, appeared to have increased
by Valdez et al. 1982a and Wick et al. 1985 (Figure 16).
5) sampled in 1982, white suckers have increased about 4-
range in the Gunnison River. YOY white sucker numbers
igh spring flows, but additional data are required to
ionship continues. Fathead minnows and sand shiners have
es, and red shiners about one and one-half times. On the
ish density has declined about 90% since 1982.

, sand shiner, and red shiner are native to rivers and
plains of Colorado. Fausch and Bramblett (1991) reported
in very harsh environments that are exposed to frequent,
table flash flooding and can survive long periods of
ppear to have an advantage during high flow years, whereas

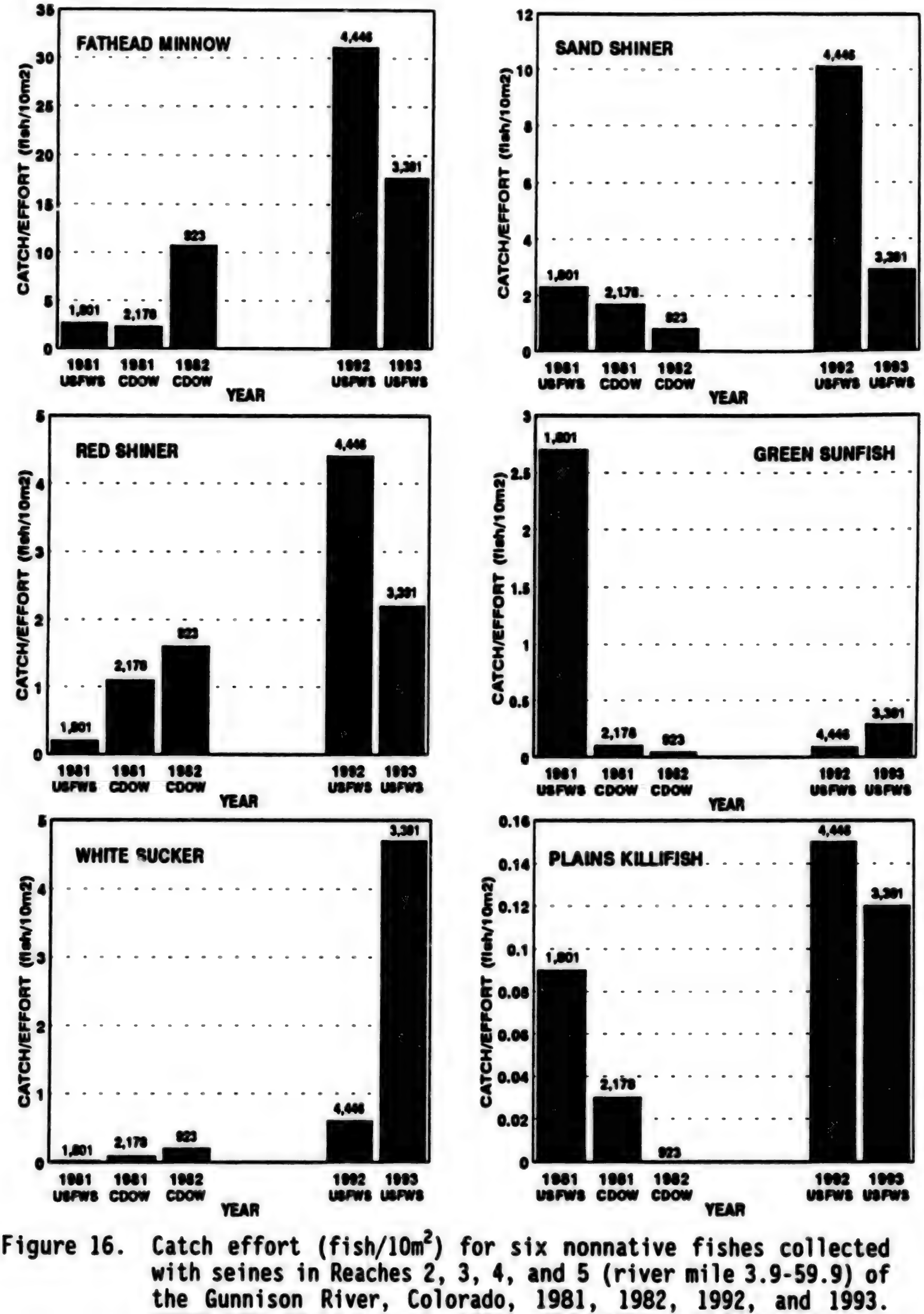


Figure 16. Catch effort (fish/10m^2) for six nonnative fishes collected with seines in Reaches 2, 3, 4, and 5 (river mile 3.9-59.9) of the Gunnison River, Colorado, 1981, 1982, 1992, and 1993. USFWS 1981 (Valdez et al. 1981), CDOW 1981 and CDOW 1982 (Wick et al. 1985), USFWS 1992 and USFWS 1993 (this study). Fish include specimens ≤ 80 mm; numbers above bars represent area seined (square meters).

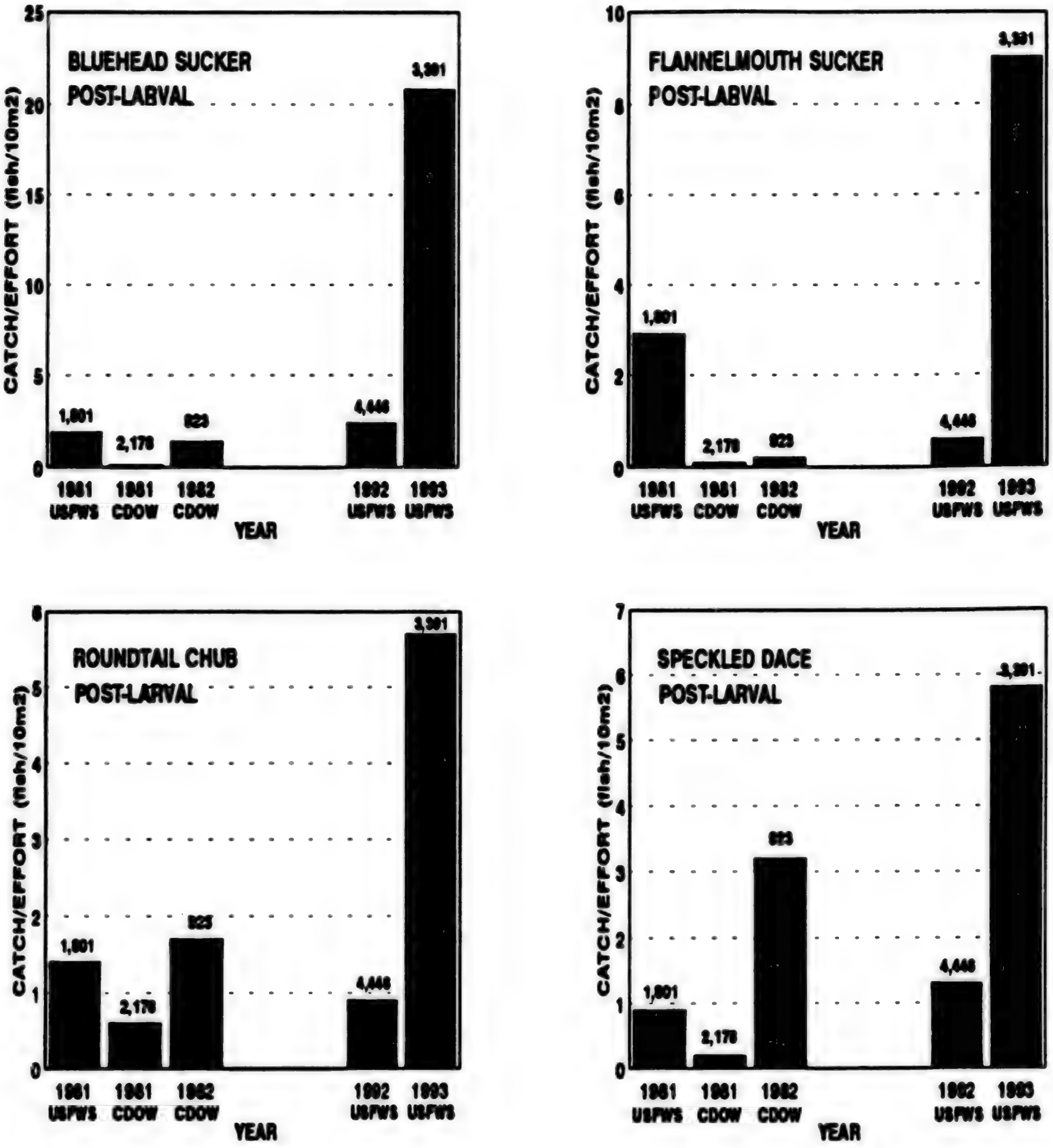


Figure 17. Catch effort (fish/10m^2) for four post-larval, native fishes collected with seines in the Gunnison River, Colorado, 1981, 1982, 1992, and 1993. USFWS 1981 (Valdez et al. 1981), CDOW 1981 and CDOW 1982 (Wick et al. 1985), USFWS 1992 and USFWS 1993 (this study). Post-larval fish include specimens ≤ 80 mm; numbers above bars represent area seined (square meters).

nonnative fish appear to fare better during low-flow years. Anderson (1994) offered a plausible explanation by suggesting that, as long as side channels are actively flowing, backwater habitats suitable for nonnative species are limited. Nonnative species are restricted to backwater habitats for their entire life cycle, whereas native fishes tend to utilize them primarily as nursery habitats. Fathead minnows and white sucker YOY were found to thrive in certain hot, shallow backwaters that were not used by native species. It is possible that native species actively avoid utilizing poor quality backwaters as nursery areas or are displaced from these backwaters by competitor species. However, it is also likely the low-velocity backwater habitats preferred by nonnative species were not commonly available under historic flow regimes during their spawning and nursery periods for most native species. The use and/or avoidance of backwater habitats by native and nonnative species supports the concept that the native fish community tends to be composed of flood-resistant species, whereas species native to the plains of eastern Colorado (fathead minnow, red and sand shiner, and white sucker) are more drought-resistant.

Valdez (1990) and Valdez and Williams (1993) suggested that periodic and temporary control measures such as floods would be ineffective for long-term control of fathead minnow, sand and red shiners. They further added that the only effective control for these nonnative species would be long-lasting and persistent measures. On the contrary, others contend that even temporary removal or suppression of nonnative predators or competitors may enhance native fishes (Minckley and Meffe 1987; Muth and Nesler 1993).

Densities of four native fishes, bluehead sucker, flannelmouth sucker, roundtail chub, and speckled dace, appeared to increase between 1982 and 1993 (Figure 17). The largest notable increase for each of these four native fishes was between 1992 and 1993.

Radiotelemetry

Colorado squawfish

Radiotelemetry provided information on movement of adult Colorado squawfish and on the locations of possible spawning areas. Seven adult Colorado squawfish were implanted with radio transmitters in 1993. Four fish (.110, .860, .920, and .960) were implanted with 360-day radiotags and three fish (.190, .510, and .990) were implanted with 280-day radiotags. Five of these fish were initially captured between Redlands Diversion Dam and the confluence with the Colorado River (Table 1) and relocated at three different locations upstream of the Dam. Two other fish, one captured at rm 16.7 and the other at rm 33.5, were also equipped with radio transmitters and released near their capture point. Two other adult males, captured on 14 July 1993 at rm 33.7, were not implanted because they were in spawning condition. Another Colorado squawfish captured near the mouth of Kannah Creek was too small to implant with a radiotag.

All seven radiotagged fish moved up- and downstream of their release site. A total of 112 individual radio contacts were made periodically with these seven fish between 3 March 1993 and 21 July 1994 (458 days; Table 7). While the number of contacts among the seven fish was similar, the duration of time contact was

Table 7. Radiotelemetry data for seven adult Colorado squawfish in the Gunnison and Colorado rivers, 1993 and 1994. Note: RM=river mile(s); radio frequencies were in the 40 Mhz band. See Figure 18 for movements of specific fish and Figure 19 for total maximum upstream and downstream displacement for each radiotagged fish.

Fish No. (Freq.)	Release RM	Number of Contacts	Duration of Contacts (Days)	Total[a] Longitudinal Movement (RM)	Maximum[b] Displacement (RM)		Final[c] Displacement (RM)
					Upstrm	Dnstrm	
1(.110)[d]	14.7	11	159	20.2	5.6	20.5	12.1(-)
2(.190)[e]	32.5	13	267	7.9	8.6	15.0	2.4(-)
3(.510)[e]	42.7	14	254	29.7	28.3	55.0	26.7(-)
4(.860)[d]	16.7	21	440	18.5	34.9	18.6	17.0(+)
5(.920)[d]	42.7	18	440	49.8	100.1	60.0	8.9(-)
6(.960)[d]	14.7	18	458	51.1	44.4	48.5	18.4(+)
7(.990)[e]	28.8	17	406	21.7	25.7	37.3	12.6(-)
Totals	--	112	--	--	247.6	254.9	62.7(-) 35.4(+)
Mean	--	--	--	29.6	35.4	36.4	12.5(-) 17.7(+)

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[a] Total longitudinal movement is defined as the most upstream contact to the most downstream contact.

[b] Maximum displacement is defined as the maximum distance moved from release point following surgery either upstream or downstream during the entire monitoring period.

[c] Final displacement is defined as the distance from point of release following surgery to the last contact point: (+) represents upstream movement, (-) represents downstream movement.

[d] Theoretical life expectancy of radiotag: 360 days.

[e] Theoretical life expectancy of radiotag: 280 days.

maintained varied greatly. Some of this variation can be explained by the theoretical life expectancy of the radiotag used (280-day versus 360-day). Some notable movement patterns were recorded for these seven adult Colorado squawfish. One fish (.110: 360-day tag) was contacted 11 times over a period of 159 days, whereas contact with another fish (.960: 360-day tag) was maintained for 458 days (Table 7). One fish (.190) maintained a small home range during the 267-day contact period. This fish, originally captured at rm 33.5, moved both up- and downstream within 7.9 miles of its capture. Two other fish (.920 and .960) ranged extensively both up- and downstream of their release point and their behavior patterns appeared to be nomadic, as if to be in a "searching mode". Fish .960, released at the Whitewater Bridge (rm 14.7) eventually moved upstream 44.4 miles to rm 59.7 on 16 May 1994, 0.2-mile downstream of Hartland Diversion. This was the farthest upstream radio contact of a Colorado squawfish in the Gunnison River during this study (Figure 18). Fish .920, which remained between rm 7 and 8 between October 1993 and May 1994, moved upstream 49.8 river miles between 11 May and 21 June to rm 57.2. This fish, originally released at the Escalante Bridge (rm 14.7), moved the most extensively up- (100.1 river miles) and downstream (60 river miles) of any of the seven fish. The mean maximum up- (35.4 miles) and downstream (36.4 miles) displacement, however, for these seven radiotagged fish were similar (Table 7; Figure 19).

Of particular interest was the movement of one Colorado squawfish (.110) previously relocated upstream and released at rm 14.7. This fish originally captured in the lower Gunnison River (rm 3.0) in March 1993 remained upstream of Redlands Diversion Dam for 78 days before moving downstream 11 river miles to the dam and ultimately over it sometime between 2 July and 2 August. This downstream movement could have been related to a spawning migration to a site in the Colorado River. The fish apparently survived moving over the 12-ft dam because it later moved back upstream into the lower Gunnison River from the Colorado River in late-August 1993 (Figure 18). This fish was never contacted by radio again. However, this fish was recaptured 25 months later on 29 September 1995 in the plunge pool (rm 3.0) of the Redlands Diversion Dam. Irving and Modde (1994) reported that eight radiotagged Colorado squawfish successfully negotiated the 60-ft high Taylor Draw Dam during their downstream spawning migration from the White River. This is an important observation because placement of a fish passageway is planned for the Redlands Diversion Dam to pass juvenile and adult Colorado squawfish from the lower Gunnison and Colorado rivers upstream. If the numbers of Colorado squawfish increase in the Gunnison River as a result of their successfully moving through the fishway, and they ultimately spawn and produce offspring, it is critical to know the survival of these fish if they move downstream over the diversion dam. It is reasonable to expect that adult Colorado squawfish can safely pass downstream over Redlands Diversion Dam given that eight fish successfully negotiated Taylor Draw Dam which is about five times higher than the Redlands Diversion Dam. However, if successful spawning occurs upstream, the fate and survival of larvae drifting downstream over the dam or being entrained into the power canal may be in doubt.

The movement patterns of the other six radiotagged fish were also interesting during late-July through mid-August 1993. Reach 4 appears to be particularly important to adult Colorado squawfish based on the frequency of radio contacts made during this and other previous studies (Archer et al. 1985). Fifty-four (48%) of 112 total radio contacts were made with radiotagged Colorado squawfish occupying Reach 4. Thirty-one percent of the radio contacts were in Reach 3. The five-mile reach between Little Dominguez Canyon (rm 30.0) and Peeples Orchard (rm 35.0) was heavily used throughout the 458-day radio contact period by six of the seven radiotagged fish. Only the Colorado squawfish that returned downstream to the Colorado River did not frequent this reach. All six fish were in this reach between 20 July and 7 August when surface water temperatures were 19-20°C. Prior to mid-July, five of the six radiotagged Colorado squawfish that would eventually converge to rm 32 and 33 exhibited

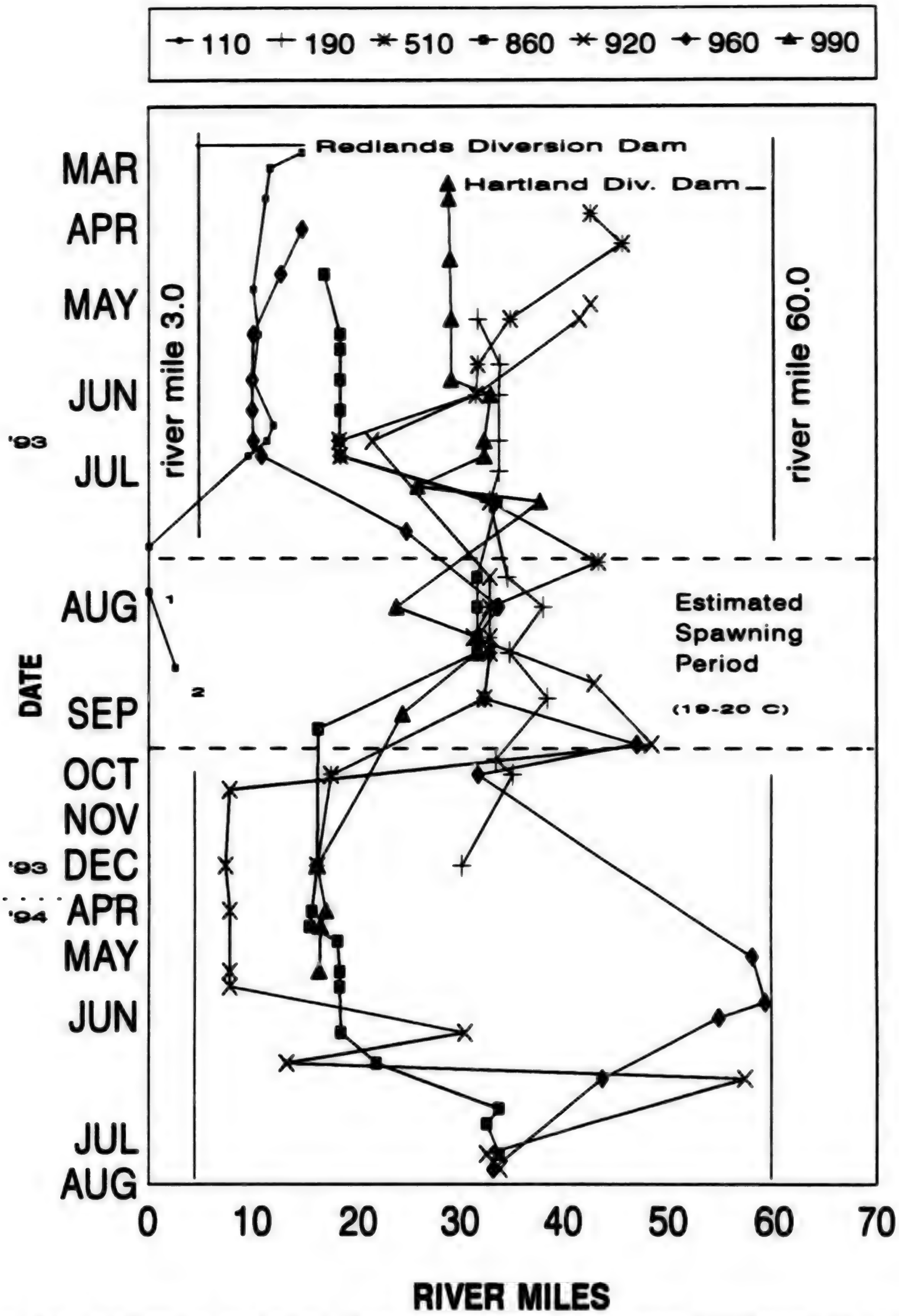

Figure 18. Movement of seven radiotagged adult Colorado squawfish in the Gunnison and Colorado rivers, 1993 and 1994. Horizontal dashed lines indicate the presumed spawning period between 20 July and 7 August 1993 when surface water temperatures were 19-20°C. Numbers adjacent to data points indicate one fish (.110) that moved over the Redlands Diversion Dam and into the Colorado River ('1'= Colorado River river mile 170.5; '2'=Colorado River river mile 167.8).

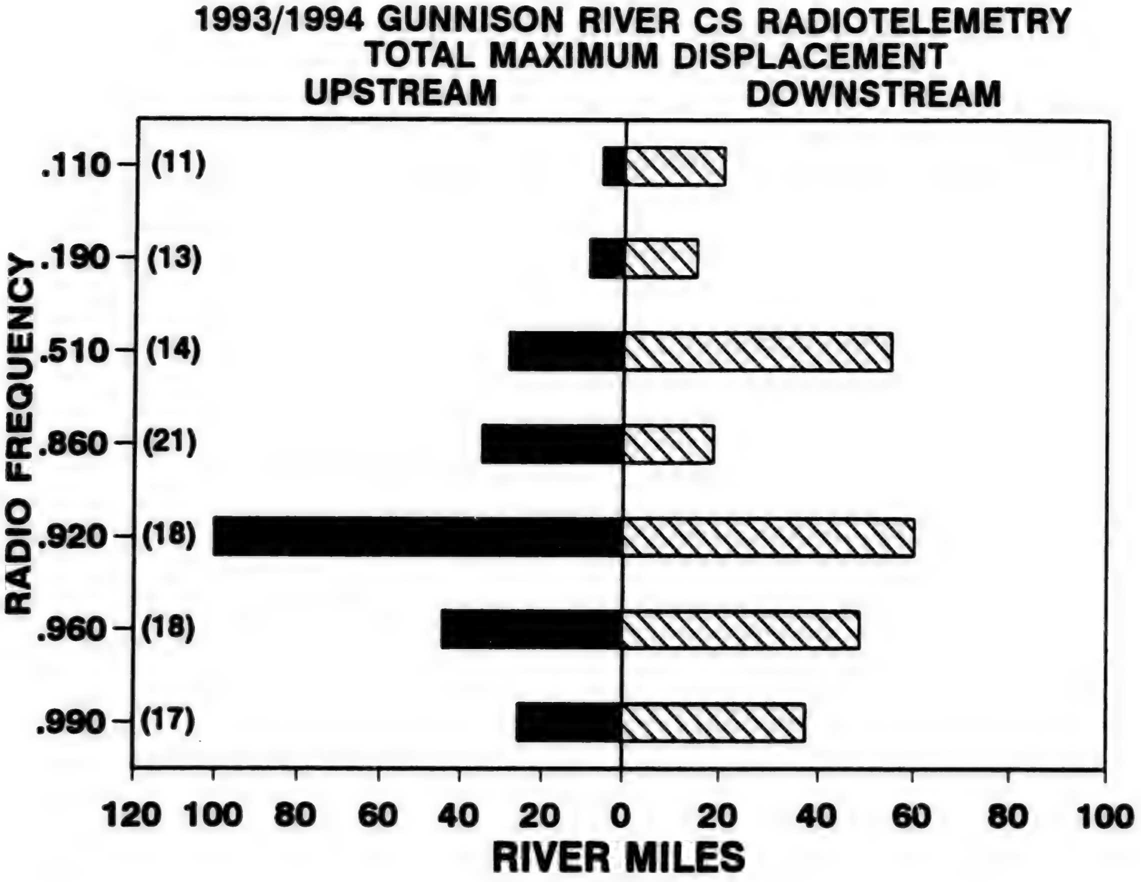

Figure 19. Total maximum upstream and downstream displacement (from release point: '0' on the X-axis) for seven radiotagged adult Colorado squawfish (CS) monitored between 3 March 1993 and 21 July 1994 (458 days) in the Gunnison River, Colorado. Number in parenthesis is the total number of radio contacts. See Table 7.

widespread movements both up- and downstream of this area. Twenty separate radio contacts were made with six different Colorado squawfish between 20 July and 20 August in Reach 4 between rm 31.6 and 35.6. Five of these six fish were in closer proximity (rm 32.8-33.7) on 30 July 1993. The maximum daily water temperature recorded at the Whitewater USGS gauge was 22.8°C on both 31 July and 1 August 1993. The estimated spawning period was between 20 July and 15 August in 1993 (Figure 15). The aggregation dispersed by early-September. Following the estimated spawning period one fish remained in Reach 4, four fish moved downstream, and one moved upstream to Reach 5. The two fish that were originally captured upstream of the Redlands Diversion Dam returned to near their initial point of capture following spawning and remained there throughout the winter. McAda and Kaeding (1991b) observed this same movement pattern following spawning for radiotagged Colorado squawfish in the Colorado River.

Surprisingly, radiotags in three of the seven Colorado squawfish transmitted longer than expected and allowed movement data to be collected until late-July 1994. At this time, the three fish were within one mile of each other in the same five-mile reach as the previous year. Prior to these three fish moving to rm 32 in mid-July 1994, one fish, .860, had spent most of its time a considerable distance downstream. Fish .960 spent most of its time upstream and fish .920, which was located downstream between October 1993 and late-May 1994, moved upstream to rm 57.2 and then returned downstream to rm 32 in mid-July 1994. These were three of the six fish that aggregated in late-July and early-August 1993 in the same 0.9-mile reach (Figure 18). One of these fish (.860) was captured upstream of Redlands Diversion Dam; the other two fish (.920 and .960) were originally captured downstream of the dam and relocated upstream. In 1994, as in 1993, fish captured downstream of the dam congregated with one fish that was known to have originated upstream of the dam. What might be as remarkable as these six radiotagged Colorado squawfish that moved to the same location and at about the same time in both 1993 and 1994 is that all six fish converged from different release sites three months later (Figure 20). Although searches were made for these three radiotagged Colorado squawfish until September 1994, no other contacts were made. It is unfortunate that contact was not maintained longer with these fish to determine if the fish would have displayed similar movement patterns as in 1993, or if they would have demonstrated fidelity to this one site. Additional adult Colorado squawfish need to be radiotagged to determine if fish continue to congregate at this same site year after year or if the fish would use other areas of the Gunnison River during the spawning period.

Reach 4 is interspersed with riffle habitat with gravel and cobble substrate, but does not appear different than other reaches in the Gunnison River. Although no ripe fish were observed or captured during July or August in either 1993 or 1994, the aggregation of these six fish suggests spawning in or near this area. If so, this may be an important reach if spawning is occurring. Four radio contacts were made with one radiotagged Colorado squawfish in this reach (rm 34.0, 33.7, 30.5, and 31.5) in September and October 1982 (Archer et al. 1985). Tuberculate Colorado squawfish have been captured as late as September from this general vicinity (Personal communication, Edmund Wick).

Although radiotelemetry provides valuable information on the spatial and temporal movements and location of adult Colorado squawfish, it provides little information about the behavior or physiology of each fish (McAda and Kaeding 1991b). However, one can speculate that the movement of six of the seven fish from up- and downstream locations to a site concurrent with descending flows when water temperatures were near or at 22-23°C may have been associated with a spawning migration. The timing of these environmental events with the movement patterns of radiotagged Colorado squawfish is consistent with spawning migrations of this species in the Colorado (McAda and Kaeding 1991b) and Green (Tyus and McAda 1984; Tyus 1984) subbasins. Two larval drift-net stations were established in the Gunnison River by CDOW in 1993, one immediately downstream of the Redlands Diversion Dam and the other upstream of the dam about 1.3 river miles. Two larval YOY Colorado squawfish were captured in a drift net in the 2.3-mile reach downstream of Redlands Diversion Dam, one each on 2 and 10 July 1992 (Anderson 1994). Because the origin of these two larval Colorado squawfish collected in 1992 was uncertain, an additional drift-net station was established near Bridgeport (rm 29.3) in 1993. This drift-net station was approximately four river miles downstream from the suspected spawning area. Despite this additional sampling station, no larval Colorado squawfish were collected from any of the three drift-net stations in the Gunnison River in 1993. Larval data for 1994

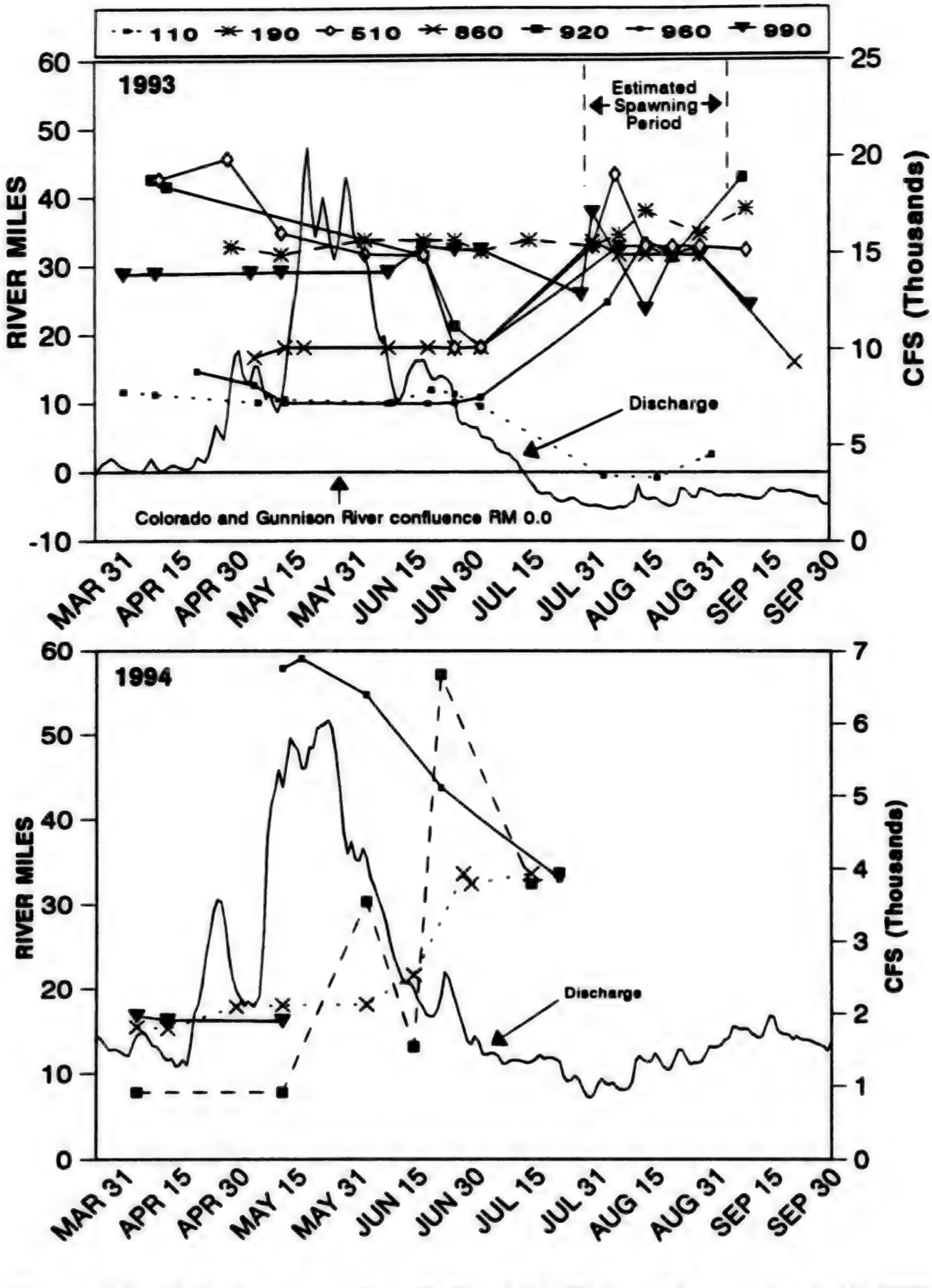

Figure 20. Radio contacts from 31 March to 30 September during both 1993 and 1994 for seven radiotagged adult Colorado squawfish (top) and four adult radiotagged Colorado squawfish (bottom) superimposed on discharge (cfs) for the same time periods. Note: "0" is the confluence of the Gunnison River with the Colorado River; discharge data from the Whitewater USGS stream gauge.

have yet to be analyzed.

Hypothetically, reduction of the historical population of Colorado squawfish in the reaches upstream of Redlands Diversion Dam may be explained by instream barriers that effectively blocked adult fish movements, especially during spawning migrations. If spawning occurred downstream of Redlands, the upstream stock would have been rapidly depleted by adults migrating downstream and over the diversion dam to spawn. On the other hand, if spawning occurred upstream of Redlands, larval drift would likely place YOY fish downstream of the diversion dam and effectively block recruitment to the adult population. Over time, the upstream populations would diminish through attrition of adults.

Although Colorado squawfish may have once spawned upstream from the diversion, it is unknown whether spawning would continue there because habitat conditions have changed following construction of the Aspinall Unit reservoirs (e.g., water temperatures have been reduced about 2° C in occupied habitat). Alternatively, adult squawfish in the historic Gunnison River might never have spawned in the Gunnison River but rather migrated downstream to spawn somewhere in the Colorado River. The adult fish then returned to feeding and wintering areas in the Gunnison. Upstream reaches in the Upper Colorado (Debeque to Rifle) and in the Gunnison River may have served historically as feeding areas for Colorado squawfish during the nonspawning season similar to the Yampa and White rivers. The Gunnison River upstream of Redlands Diversion Dam would provide an ample native fish food base for adult Colorado squawfish.

The Redlands Diversion Dam was completed in 1918 and has been an effective barrier to upstream movement of fishes for nearly 75 years. However, some researchers (Valdez et al. 1982a) suggest that it is possible that adult fish could move upstream of the Redlands Diversion Dam in the Gunnison River via a three-foot culvert bypass that connects the Redlands Canal with the Gunnison River or through the sluice gates when the gates were opened to remove sediment from behind the dam. The likelihood is remote that a population upstream of the dam is as old or older than the dam. It is more likely that fish have passed through a culvert at the Redlands Diversion Dam to colonize reaches upstream of the dam or some successful spawning and recruitment may have occurred upstream following completion of Redlands Diversion Dam. Another explanation for existence of Colorado squawfish upstream of the dam is that these fish are survivors of the fish stocked in 1984. These fish would be 10-11-year old adults and the possibility exists that the coded-wire tag was not detected because the tag was lost, migrated, or was deeply imbedded within fish tissue.

Five of the seven Colorado squawfish radiotagged in this study were initially captured downstream of Redlands Diversion Dam and transplanted upstream of the dam. It is unknown whether fish were offspring of adult fish upstream of the dam that later migrated downstream over Redlands Diversion Dam as YOY, juveniles, or adults. During July and August of 1993, all six radiotagged fish converged to a 0.9-river mile section. Four of these fish, that were initially captured downstream of Redlands Diversion Dam, congregated with two fish captured upstream of the dam. The mechanism by which Colorado squawfish congregate in spawning areas is unknown, but laboratory studies are currently underway by Dr. Al Scholz to determine if these fish exhibit a homing response to olfactory cues. Preliminary results from Scholz' studies (Horton and Scholz 1993; Scholz et al.

1984; Scholz et al. 1993) with Colorado squawfish indicate that they exhibited thyroid hormone surges at hatch and swim-up stages when subjected to very small concentrations of synthetic chemicals (morpholine and phenethyl alcohol). Results from planned behavioral tests with adult Colorado squawfish and field studies will be gathered and analyzed to determine if they can be attracted to a specific site using the same chemicals that they were subjected to in their early life stages.

In the Upper Colorado and Gunnison rivers, fish migrations to historical spawning areas have been disrupted by instream barriers. In the Colorado River, additional spawning sites of Colorado squawfish are occasionally discovered. It is unknown whether these are new spawning sites or are sites that have been previously used but overlooked during sampling. If spawning sites are destroyed or become unsuitable because of flood events, or fish are denied access to upstream spawning areas by instream barriers, fish may seek alternate or new spawning sites. In such instances, natal imprinting is either not important or other mechanisms are used to attract and congregate fish to a spawning site. The Colorado squawfish successfully evolved over millions of years adapted to a river system with extreme flow fluctuations that changes their habitats. It has survived and persisted by developing a life strategy to cope with climatic and habitat changes (Tyus 1986). It developed reproductive strategies dependent on habitats created by the annual streamflows. Therefore, this species has developed a reproductive strategy that incorporates migration and long-distance movement patterns that attract fish to an area where they can spawn successfully and recruit individuals to the population. The advantage of fish spawning in discrete areas allows genetic exchange and to maintain a high genetic diversity in the population.

Data from both radiotelemetry and conventional tagging studies indicate that Colorado squawfish in the Green River subbasin exhibit repeat migrations to spawning sites (Tyus 1985; 1987; 1990). Other investigators (Tyus 1986; 1990; Wick et al. 1983) have speculated that larval fish may imprint to distinctive odors that identify their hatching sites, then use long-term memory to relocate the site by olfaction during their spawning migration.

Because we do not have definitive information on hatching locations of the four Colorado squawfish that were captured downstream of Redlands Diversion Dam and later relocated upstream, we can only postulate on why they congregated with two fish that originated upstream of the dam. There are several possible scenarios. If these four originated in the Colorado River, why didn't they exhibit downstream migration to the Colorado River during the spawning season? This suggests that fish either were attracted to the site because they were imprinted to the site as young fish or were attracted by odors from resident spawning fish. If the later scenario is true, this suggests that a mechanism(s) other than natal imprinting is operative. Therefore, the mechanism that allowed them to congregate with the two resident fish was not learned or from genetic memory. The two resident fish could have been the first fish attracted to this area. These two fish, as embryos or larvae, may have imprinted on odors in the areas in which they developed and later oriented to these odors as spawning adults. The first fish on the spawning grounds could have then released conspecific odors (i.e., pheromones) that acted as generalized attractants for other fish to "key in on". Although unknown for Colorado squawfish, more subtle cues may include several environmental components, perhaps even reproductive by-products from previously hatched young, all of which may constitute a home-site "olfactory bouquet" (Tyus 1990). Another scenario is that fish could have simply selected this site because spawning substrate was suitable. Colorado squawfish may have specific habitat requirements for spawning that are related to physical conditions such as flow and substrate (Harvey et al. 1993).

However, if all four fish originated upstream, then there is stronger evidence to suggest that these fish imprinted to this site as larvae. Although there is no experimental evidence to date that confirms or disproves the existence of an olfactory imprinting mechanism (Hasler and Scholz 1993) for Colorado squawfish, Tyus (1985) believed that such a mechanism was operational at a spawning ground on the Yampa River (Yampa Canyon) and in the middle Green River (Gray Canyon). Results to date from chemoreception studies by Scholz et al. (1994) do not discredit the natal imprinting hypothesis, nor do they substantiate it.

Colorado squawfish may have 'backup' or alternative mechanisms that are used in the event that the primary mechanism has failed or has never been activated. For example, fish may be attracted to a spawning area by odors released by spawning fish, even though they may have never been to the site. For instance, a non-imprinted hatchery-reared Colorado squawfish that was implanted with a coded-nose-wire tag at the hatchery and released later in the Colorado River near Grand Junction as a fingerling was recaptured about 11 years later in the Grand Valley with wild adult Colorado squawfish that were in spawning condition (Personal communication, Douglas B. Osmundson). Although this observation is only from one fish, the implication is that fish may not have to be imprinted at an early life stage to successfully congregate with wild spawning fish. Movements of fish to spawning sites in both up- and downstream directions are also suggestive of an olfactory orientation mechanism (Harden-Jones 1968; Hasler and Scholz 1983). This hypothesis is consistent with observations made by Hasler and Scholz (1983) that salmon responded more strongly to odors released by other salmon that already had ascended tributaries and were on the spawning grounds of the Great Lakes.

Tyus (1985) also postulated that some river reaches are geo-hydrologically different from those immediately upstream, and Colorado squawfish could select spawning sites that receive freshwater input from groundwater seeps unique to the area. The fish use the input of groundwater in these locations as a means of orientation. He suggested that the "Groundwater Seepage Hypothesis", proposed by Harden-Jones (1981), might be another possible mechanism. If such a mechanism is operating, the larval squawfish would have to be imprinted at an early life stage, since they drift downstream soon after hatching. Tyus (1990) further pointed out that the presence of springs and other water inputs of two spawning reaches in the Green River subbasin may have provided olfactory cues. Tributaries such as Florence Creek (Middle Green River) and Warm Springs (Yampa River) may provide gross cues for long-distance piloting to the spawning reach, and more subtle cues unique to specific spawning sites may further guide the fish once it is in the reach. This might explain why the two fish captured upstream of Redlands Diversion Dam were attracted to this area. However, if the four fish that were relocated upstream of Redlands Diversion Dam did not originate upstream, the Groundwater Seepage Hypothesis does not explain why these fish congregated with two other fish captured upstream of the dam. Little Dominguez Creek, a tributary that flows into the Gunnison River approximately two river miles downstream of the site where six adult Colorado squawfish congregated in 1993, might be similar to Florence Creek and Warm Springs in that it may provide olfactory cues to attract Colorado squawfish, imprinted as larvae, to the general area.

There is a possibility that Colorado squawfish may have a predominant homing mechanism, but in the event that this fails, they may have the ability of using another mechanism or a combination of mechanisms to be attracted to specific sites. Fish of the order Cypriniformes are highly sensory receptive to chemicals and may have redundant homing mechanisms (Personal communication, Al Scholz). Scholz et al. (1994) reports that both the native Colorado squawfish and razorback sucker could detect morpholine and phenethyl alcohol at concentrations approximately 10 to 100 times lower than salmonids detect the same chemicals, indicating that both species are chemoreceptive. The converging of six radiotagged Colorado squawfish in 1993 and three fish in 1994 that aggregated within a 1-mile section during mid-July to mid-August suggests possible spawning behavior. The circumstances of the behavior and movement of the six Colorado squawfish radiotagged in the Gunnison River that eventually converged at this one site in both 1993 and 1994 suggest that further field investigations are needed that might provide new insight into the mechanism(s) that allow this species to be attracted or home to certain areas during specific times of the year.

SYNTHESIS

Native vs. Nonnative Fish Assemblage

The Gunnison River upstream of Redlands Diversion Dam is predominantly composed of native fishes that probably resembles the historic composition of the fish community, compared to reaches downstream in the Colorado River that are composed primarily of nonnative fishes. Although high spring streamflows have been reduced in the Gunnison River as a result of the operation of the Aspinall Unit, native fish populations persist. The fact that native species composition approaches 80% for all large-sized fishes upstream of the dam is an encouraging sign for recovery of Colorado squawfish and razorback sucker. One reason that native fish populations tend to still be predominant in the Gunnison and the Upper Colorado rivers is that diversion dams have effectively served as barriers to prevent upstream movement of and colonization by some nonnative fishes. Nonnative fishes have been prevented from moving to upstream reaches from the Redlands Diversion Dam on the Gunnison River and Government Highline Diversion Dam on the Upper Colorado River since 1918 and 1917, respectively. For example, Valdez et al. (1982b) reported that nonnative fishes comprised 70% and 95% of the fishes collected by electrofishing and seining, between 1979 to 1981, respectively, in the Colorado River between the confluence of the Green River to Westwater Canyon. During the same period of time, nonnative fishes comprised 25% and 56% of the fish collected by electrofishing and seining, respectively, from Westwater Canyon upstream to Palisade, Colorado. During that time, Valdez et al. reported that native fishes between Debeque and Rifle, Colorado comprised 93% and 43% of all fishes collected by electrofishing and seining, respectively. In 1993, Anderson (1994) found that native fishes comprised 85% of the fish community in the reach between Debeque and Rifle based on electrofishing collections. The difference between the two time periods might be due to differences in sampling during the two studies or might reflect an increase in the numbers of minnow-sized nonnative fishes (e.g., red shiner, sand shiner, fathead minnow). The fish community structure for larger-sized fish in the Colorado River steadily changes moving upstream--the relative abundance of nonnative fish numbers decline whereas native fish numbers increase.

In recent years, the numbers of nonnative minnow species appear to have increased in the Colorado River during the 9-year period from 1986 to 1994 based on seining backwaters (McAda et al. 1994a; McAda et al. 1994b; McAda et al. 1995). Nonnative fishes comprised 98.6% of fishes collected from stream reaches between the Green River confluence 110-miles upstream to Fish Ford. Nonnative fishes comprised 96.4% of fishes collected in a 37-mile reach from the Gunnison River confluence downstream to the Utah/Colorado State Line. During August 1995, the CDOW electrofished 33 miles of the Colorado River from the confluence of the Gunnison River downstream to the Utah/Colorado State Line and reported that native fishes comprised 85% of the fishes collected (CDOW unpublished data). The relative abundance of species collected by electrofishing during the CDOW study does not differ significantly from the relative abundance of species reported during electrofishing surveys (native: 75%) in the same reaches from 1979 to 1981 (Valdez et al. (1982b). Differences in the composition and abundance of fish species obtained by sampling with electrofishing and seining reflects gear selectivity and the time of year sampled. Electrofishing is more effective in sampling larger fishes while seining is more effective in sampling smaller fishes. Differences in the species composition from seine samples suggests that small, nonnative minnows have effectively invaded the Upper Colorado River and now comprise a higher percentage of the fish community based on numbers.

Although there is now a higher relative abundance of nonnative, small-bodied minnows in portions of the Upper Colorado River in Colorado and the Gunnison River, the presence and interaction of these species has not affected the relative abundance of native adults, which have continued to dominate the fish community. This appears likely due in part to periodic recruitment success by native species that may be associated with high flows and other favorable factors. There is evidence that nonnative fish densities are reduced during the summer following a high spring streamflow and densities of native fishes increase. Streamflows that mimic the historical hydrograph by increasing the magnitude and lengthening the duration of spring flows can be used as a management tool to create habitat for native fishes and, at the same time, possibly control the smaller nonnative fishes in the Gunnison River.

Another reason that native fishes might be more abundant in some stream reaches is higher diversity and greater availability of food items. A current study is investigating the interaction of streamflows and dynamics of the food web (Osmundson FWS). This food-web study will provide additional information to develop and refine flow recommendations for the Upper Colorado and Gunnison rivers. This study will attempt to determine if the longitudinal distribution and densities of native bluehead sucker, flannelmouth sucker, and roundtail chub are related to the available food web. Further, it will attempt to determine if primary food production (algal and invertebrate) might be correlated with the geomorphic characteristics (e.g., substrate type and size, channel morphology, and stream gradient) of a reach. The study will further determine if migration of Colorado squawfish to upstream reaches may be in response to higher concentrations of native food fishes that serve as prey and that downstream reaches in the Colorado River (predominantly sand substrate) have lower carrying capacities for both non-piscivorous native fish as well as for piscivorous adult squawfish.

Upstream movements by adult squawfish may be short-term (annual). Moreover, there may be a gradual, long-term upstream movement by juvenile and sub-adult squawfish. As they mature, they steadily move into upstream reaches and tributaries (Tyus 1986). This life history strategy may explain why adult Colorado squawfish move to upstream reaches of the Yampa and White rivers following spawning in the Green River subbasin and remain in those reaches until the following spawning season. In the White River, native fishes are more abundant in Colorado than Utah waters, although the distribution of nonnative fishes has slowly moved upstream following the completion of Taylor Draw Dam in 1984 (Irving and Modde 1994). Native fishes now are dominant only in the 24-mile reach immediately downstream of the dam. Although Colorado squawfish cannot migrate upstream of Taylor Draw Dam, it is speculated that they historically migrated further upstream to feed predominantly on abundant native fishes. In reaches of the Gunnison River and Upper Colorado River from Debeque to Rifle, native fish densities may be higher than downstream reaches in the Colorado River because the diversity and abundance of various food items are greater. Thus, carrying capacities for native fishes are higher in these tributary and upstream reaches.

Restoration Activities for the Gunnison River

Fish Passage

One important facet to the recovery of both Colorado squawfish and razorback sucker is the construction of a fish passageway at the Redlands Diversion Dam during 1995 and 1996. This fishway should be operational in the spring of 1996. The purpose of the fishway is to provide passage for sub-adult and adult Colorado squawfish and razorback sucker upstream of the dam. The fishway will extend the range of these two native fishes upstream about 50 miles into historical habitat and may allow Colorado squawfish to naturally re-colonize these upstream reaches. An important feature of the fishway will be installation of a fish trap at the upstream end to capture sub-adult and adult fishes and prevent upstream colonization of nonnative fishes. If nonnative fishes, such as channel catfish (that presently do not occupy the Gunnison River upstream of the dam) use the fishway, maintenance of the native fish community upstream of the dam may require that the trap be operated continually to remove nonnative fish and prevent them from continuing upstream. Colorado squawfish and razorback sucker that enter the trap will be allowed to continue their movements upstream.

Instream barriers are largely to blame for the loss of stream passage and reduced range of these two fish in the Gunnison River to Delta and in the Upper Colorado River (Debeque to Rifle). Instream barriers have resulted in stream reach fragmentation that has reduced the historic range of the Colorado squawfish in the Upper Colorado River Basin (Tyus 1984; Burdick and Kaeding 1990) and may have been a factor that contributed to the extirpation of Colorado squawfish in the Lower Colorado River downstream of Glen Canyon Dam (Nicola 1977). Colorado squawfish move long distances during spawning migrations and exhibit seasonal movements to feeding areas. If sub-adult and adult Colorado squawfish successfully use the fishway at Redlands, it is uncertain whether these fish will spawn in upstream reaches. Even if they do not spawn, the reaches upstream of the dam will provide additional physical habitat and an abundant source of native and nonnative fishes for food. Native flannelmouth sucker, bluehead sucker, roundtail chub, and speckled dace were historical prey for Colorado squawfish. However, YOY Colorado squawfish have been reported (Jacobi and Jacobi 1982) to feed on red shiners where they are abundant--reflecting that they are opportunistic feeders. Red shiners, fathead minnows, and sand shiners are prevalent species found upstream of Redlands Diversion Dam and would provide an ample food base for juvenile and adult Colorado squawfish. One advantage of native fish prey would be they offer larger prey sizes than the small-bodied nonnative minnows to larger adult Colorado squawfish.

An important aspect of the fishway is that it will allow natural recolonization by Colorado squawfish from reaches downstream of the dam and possibly establish a permanent Colorado squawfish population in the Gunnison River. If sub-adult and adult Colorado squawfish successfully use the fishway, it will eliminate the need to translocate fish from downstream reaches as was necessary during this study. During this study, it was assumed that fish captured in the lower Gunnison River had an affinity to ascend further upstream if not hindered by instream barriers. Thus, fish that were translocated in this study were captured only from the lower Gunnison River. However, translocating fish is artificial and has the following implications: 1) selecting fish is random and indiscriminate, i.e, it is unknown whether the fish selected actually desire to move further upstream, 2) numbers of fish from downstream populations may be reduced and may lead to temporarily relocating fish unnecessarily to upstream reaches that would have not normally passed through the fishway, 3) it may not be "timed" to the physiological need of Colorado squawfish to move upstream, and 4) fish may be artificially attracted to upstream spawning areas.

Providing passage past instream barriers is considered to be an important element in providing habitat for these two native endangered fishes. In addition, new barriers should not be constructed within the current range of these two species.

Flow Management

Lower Gunnison River. A study presently underway to recommend streamflows in the 2.3-mile reach between the Redlands Diversion Dam and the confluence of the Colorado River is also another important step in the recovery of these two native fishes in the Gunnison River. The FWS developed a provisional minimum flow recommendation of 300 cfs in 1994 for this reach based on analyses of existing Colorado squawfish habitat use and flow data. In the past, flow has essentially ceased in this reach for several days during low-flow periods which has resulted in loss of habitat and possible stranding of fish. Legalizing flows will provide maintenance habitat and a migration corridor for fishes moving either up- or downstream of the fishway during these low-flow periods. The presence of sub-adult and adult Colorado squawfish in the lower Gunnison River (20 captures during mid-July to mid-August 1994) suggests that this reach has importance in addition to a passage corridor. The high use by Colorado squawfish during this period suggest that this reach might be a spawning or post-spawning feeding area. The seasonal abundance of Colorado squawfish in this reach may also be attributed to forced congregation because Redlands Diversion Dam limits upstream movement. Large concentrations of native bluehead sucker and flannelmouth sucker have been observed immediately downstream of other instream barriers (e.g., Government Highline and Hartland Diversion) during electrofishing operations.

Upper Gunnison River. In addition to providing flows for the 2.3-mile reach downstream of Redlands Diversion Dam, flow recommendations for the remaining warmwater reaches upstream will be key to the restoration effort. Implementing streamflows that will mimic the historical hydrograph to increase the magnitude and lengthen the duration of spring flows to create and provide riverine habitat for native fishes and at the same time control the smaller nonnative fishes in warmwater reaches (Austin to the Colorado River confluence) of the Gunnison River. These biologically-based flow recommendations are forthcoming and will provide the basis for a Biological Opinion on the operation of the Aspinall Unit. The ultimate goal is to recommend year-round flows that will benefit endangered and native fishes in occupied habitat.

Bottomland Restoration

Another element of the Recovery Program is habitat enhancement and restoration. Restoration of wetland habitats adjacent to the river corridor that flooded historically but are no longer inundated during runoff is an important factor in the reestablishment of self-sustaining razorback sucker populations in previously occupied stream reaches of the Gunnison River. Historically, young razorback sucker larvae drifted downstream during runoff after hatching into warmer, highly productive floodplain habitats that served as nursery areas. The present theory is that these floodplain areas served as critical nursery habitat for larval razorback sucker by producing hundreds of times more zooplankton than river channels and backwaters. The ultimate goal is not to re-create the entire historical floodplain, but to restore or enhance some natural floodplain functions that are vital for survival during early life stages.

Studies presently underway will identify the magnitude and frequency of spring flows necessary to sufficiently inundate floodplain sites and thereby provide important razorback sucker spawning and nursery habitat. It is critical that high spring flows be provided to hydrologically reconnect floodplain areas with the river during runoff more frequently to provide habitat for early-life stages of endangered fishes. Several floodplain sites in a 17-mile reach along the Gunnison River near Delta have been identified that could be reconnected to the river via a combination of flows and removal of levees (Irving and Burdick 1995).

Geomorphology Studies

Other ongoing relevant studies include research conducted by geomorphologists from the National Ecology Research Center in Ft. Collins, Colorado, that will determine threshold (flushing) flows necessary for transport of sediment in the Gunnison River. This information will be useful in determining flows necessary for periodic bar-building, chute-cutting, and general reconfiguring of the channel to create and maintain a diversity of habitats. Moreover, the cleansing of cobble substrate might be vital to providing suitable spawning substrate for both Colorado squawfish and razorback sucker in the Gunnison River (Osmundson et al. 1995).

Experimental Razorback Sucker Reintroduction

The Gunnison River has been selected as an initial site for experimental stocking of juvenile and sub-adult razorback sucker. Various sizes (4-inch, 8-inch, and 12-inch) of razorback sucker will be stocked in the Gunnison River over a 5-year period, starting in the fall of 1996, to evaluate the relation between survival and size at release. In September 1995, 316 juvenile (4-6-inch) razorback sucker were stocked into the Gunnison River immediately downstream of Hartland Diversion Dam. The short-term goal of this stocking program is to reintroduce fish to stabilize a razorback sucker population in the Gunnison River. The long-range or ultimate goal is to establish self-sustaining populations of at least 10 adult razorback sucker per river mile in the Gunnison River.

A very positive factor for razorback sucker reintroduction is the absence of channel catfish and other piscivorous, nonnative game fishes in the Gunnison River. Although northern pike occupy the Gunnison River, their numbers are low and they do not appear to be reproducing in the Gunnison River. In addition, a program is presently underway to remove and relocate pike to off-channel, lacustrine waters that will decrease pike predation on stocked razorback sucker.

RECOMMENDATIONS

1. Continue larval and post-larval fish sampling in August and September, respectively, to determine if spawning of Colorado squawfish occurs in the Gunnison River upstream of Redlands Diversion Dam. Additional data are also needed to determine if the densities and relative abundance of nonnative fishes are reduced in the summer following high spring flows and if the densities of native fishes increase. If these relationships are valid, recommendations can be made for managing flows in the Gunnison River to reduce the abundance of nonnative fishes while, at the same time, benefiting native fishes such as young Colorado squawfish and razorback sucker to aid in their recovery. Re-operation of the Aspinall Unit, as the result of Section 7 consultation, could provide a more natural hydrograph, possibly improving habitat for endangered fish.

2. Continue larval drift netting in the Gunnison River at three locations: 1) near Bridgeport (rm 29.3), 2) immediately upstream of Redlands Diversion Dam (rm 5.3), and 3) immediately downstream of Redlands Diversion Dam (rm 2.7). Any squawfish larvae produced from spawning in a specific reach of the Gunnison River, (e.g., rm 30-35) would drift downstream to the Colorado River where they would occupy nursery habitats. This would be best determined by monitoring larval drift at different downstream locations to aid in identifying adult spawning areas and to confirm successful squawfish reproduction.

3. Establish juvenile and adult monitoring stations to note any major changes in numbers, composition, and density of native and nonnative fish populations. Trend stations should be established similar to that of the ISMP for sampling adults in the spring of the year.

4. Conduct additional movement studies of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam. If the fishway at Redlands Diversion Dam is constructed and is operational in 1996, Colorado squawfish caught in the upstream fish trap could be implanted with radiotags. As part of the evaluation of the fishway, Colorado squawfish captured downstream of the dam in the plunge pool and 2.3-mile reach between the dam and the Colorado River confluence will be implanted with radio transmitters. If these radiotagged fish successfully negotiate the fishway, they will be caught in the fish trap. Radiotagged Colorado squawfish caught in the fish trap could then be either allowed to continue upstream of the dam or transported further upstream, released, and their movements monitored. However, if Colorado squawfish fail to use the fishway, fish captured in the plunge pool and in the 2.3-mile reach downstream of the dam could be radiotagged and relocated upstream of the dam. Up to 10 adult Colorado squawfish could be used for this study.

   Additional information on movement of Colorado squawfish in the Gunnison River upstream of Redlands Diversion Dam is necessary to determine if spawning occurs, and if it does, the location, time of spawning, and if fish exhibit fidelity to a specific area. Additional data would build upon the movement information obtained in 1993 and 1994, and might provide insight into the mechanism(s) that allow this species to be attracted or home to specific areas during the spawning season.

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APPENDIX A

Scientific and Common Names of Fishes Collected During the Gunnison River Ichthyofaunal Survey, 1992 and 1993

Table A.1. Scientific and common names, status (native vs. non-native), and two-letter code of fish collected during the Gunnison River ichthyofaunal survey, 1992 and 1993.

Scientific Name	Common Name	Status	Code
Salmonidae			
Oncorhynchus mykiss	rainbow trout	non-native	RB
Salmo trutta	brown trout	non-native	BN
Cyprinidae			
Cyprinella lutrensis	red shiner	non-native	RS
Cyprinus carpio	common carp	non-native	CP
Gila robusta	roundtail chub	native	RT
Gila cypha	humpback chub	native	HB[a]
Notropis stramineus	sand shiner	non-native	SS
Pimephales promelas	fathead minnow	non-native	FH
Ptychocheilus lucius	Colorado squawfish	native	CS[a]
Rhinichthys osculus	speckled dace	native	SD
Catostomidae			
Catostomus catostomus	longnose sucker	non-native	LS
Catostomus discobolus	bluehead sucker	native	BH
Catostomus latipinnis	flannelmouth sucker	native	FM
Catostomus commersoni	white sucker	non-native	WS
C. discobolus X C. latipinnis	bluehead X flannelmouth	native	FB
C. discobolus X C. commersoni	bluehead X white	non-native	WB
C. commersoni X C. latipinnis	flannelmouth X white	non-native	WF
Ictaluridae			
Ameiurus melas	black bullhead	non-native	BB
Ictalurus punctatus	channel catfish	non-native	CC
Centrarchidae			
Lepomis cyanellus	green sunfish	non-native	GS
Micropterus dolomieui	smallmouth bass	non-native	SM
Micropterus salmoides	largemouth bass	non-native	LG
Esocidae			
Esox lucius	northern pike	non-native	NP
Cyprinodontidae			
Fundulus zebrinus	plains killifish	non-native	PK
Cottidae			
Cottus bairdi	mottled sculpin	native	MS

[a] Federally listed as "endangered".

APPENDIX B

Landmark Descriptions, River Miles of Common Locations, and Length of Stream Reaches for the Gunnison River Ichthyofaunal Survey

Table B.1. River miles of common locations on the Gunnison River extending from the Colorado River confluence upstream 75 river miles to the confluence of the North Fork, in addition to the length of the seven stream reaches inventoried during the study.

RIVER MILE	LOCATION DESCRIPTION
0.7	Former Colorado/Gunnison River confluence
3.0	Redlands Diversion Dam Boat Landing (river right)
3.9	Elam Boat Landing (river right)
14.6	Whitewater Boat Landing (river left)
29.3	Bridgeport Boat Landing (river right)
34.6	Peeples Diversion (far right channel)
36.1	Broughton Diversion
42.6	Escalante Boat Landing (river right)
50.3	Railroad Bridge
54.0	Escalante County Bridge
56.3	Uncompahgre River confluence
57.1	Confluence Park Boat Landing (river left)
57.3	Flying "A" Motel Boat Landing (river right)
57.6	Delta 6 & 50 State Hwy Bridge
59.7	Lower Hutchins Boat Landing (river left)
59.9	Hartland Diversion
60.1	Upper Hutchins Boat Landing (river left)
61.4	Carver Boat Landing (river left)
62.5	Cedaredge Bridge (State Hwy 65)
65.0	Austin Boat Landing (river left)
65.2	Austin Diversion
66.7	Drysdale Flats Boat Landing (river right)
70.8	Ferganchick Diversion
74.9	North Fork/Gunnison River confluence Pleasure Park Boat Landing (river right)

Gunnison River Stream Reach	Landmark Description	River Miles	Length (mi)
1	Colorado/Gunnison R. Confluence to Redlands Diversion Dam	0.7-3	2.3
2	Redlands Div. Dam to Whitewater	3- 15	12
3	Whitewater to Bridgeport	15- 30	15
4	Bridgeport to Escalante Bridge	30- 42	12
5	Escalante Bridge to Hartland Diversion Dam	42- 58	16
6	Hartland Diversion Dam to Smiths Mountain (Drysdale Flats)	60- 67	7
7	Smiths Mountain to Confluence w/ North Fork of the Gunnison River	67- 75	8

APPENDIX C

River Miles and Dates Sampled for Fishes Collected, by Electrofishing, 1992 and 1993, and Sampling Dates for Larval and Post-larval Fishes, 1992 and 1993

Table C.1. River miles and dates sampled for fishes collected by electrofishing for each of the seven reaches and four rotations, Gunnison River, 1992. Sampling gear used was boom electrofishing mounted on a rubber raft and aluminum jon boat.

	River Miles	Dates MM/DD[a]		River Miles	Dates MM/DD
Rotation 1 (April) Reach			Rotation 3 (July) Reach		
1	3.0-0.7	04/21	1	3.0-0.7	07/27
2	10.0-9.5	04/14	2	12.0-11.5	07/21
	9.5-5.0	04/15		11.0-7.0	07/21
	5.0-4.5	04/15		7.0-6.5	07/22
3	28.0-27.5	04/13	3	41.0-40.5	07/20
	27.5-23.0	04/14		40.5-36.0	07/20
	23.0-22.5	04/14		36.0-35.5	07/21
4	39.0-38.5	04/08	4	41.0-40.5	07/15
	38.5-34.0	04/09		40.5-36.0	07/15
	34.0-33.5	04/09		36.0-35.5	07/16
5	52.0-51.5	04/06	5	48.0-47.5	07/14
	51.5-47.0	04/07		47.5-43.0	07/14
	47.0-46.5	04/07		43.0-42.5	07/15
	59.9-57.0	04/24		59.9-57.0	07/30
6	66.9-60.0	04/22	6	66.9-60.0	07/31
7	67.0-74.9	04/23	7	67.0-74.9	N/S[b]
Rotation 2 (May/June) Reach			Rotation 4 (October) Reach		
1	3.0- 0.7	06/01	1	3.0-0.7	09/21
2	15.0-14.5	05/27	2	12-11.5	09/29
	14.5-10.0	05/27		15.0-12.0;4.5-3.0	09/29;09/30
	10.0- 9.5	05/28		5.0-4.5	09/30
3	21.0-20.5	05/26	3	29.0-28.5	09/28
	20.5-16.0	05/26		30.0-29.0;18.5-15.0	09/28;09/29
	16.0-15.5	05/27		19.0-18.5	09/29
4	36.0-35.5	05/20	4	42.0-41.5	10/07
	35.5-31.0	05/21		41.5-37.0	10/07
	31.0-30.5	05/21		37.0-36.5	10/08
5	55.0-54.5	05/19	5	54.0-53.5	10/06
	54.5-50.0	05/18		53.5-49.0	10/06
	50.0-49.5	05/18		49.0-48.5	10/07
	59.9-57.0	06/03		59.9-57.0	09/24
6	66.9-60.0	06/02	6	60.0-66.9	N/S
7	66.9-74.9	06/04	7	67.0-74.9	N/S

[a] MM/DD = month and day.

[b] N/S = stream reach not sampled.

Table C.2. Larval and post-larval fish sampling dates for stream reaches 2-5, Gunnison River, 1992 and 1993. Sampling gear used was a seine.

	1992 Sampling Dates MM/DD		1993 Sampling Dates MM/DD	
Reach	Larval	Post-larval	Larval	Post-larval
2	08/03	09/11	08/04	09/10
3	08/04	09/10	08/03	09/09
4	08/07	09/09	08/06	09/08
5	08/05	09/08	08/05	09/07

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Table C.3. River miles and dates sampled for fishes collected by electrofishing for each of the seven reaches and three rotations, Gunnison River, 1993. Sampling gear used was boom electrofishing mounted on a rubber raft and aluminum jon-boat.

	River Miles	Dates MM/DD[a]		River Miles	Dates MM/DD
Rotation 1 (April/May)			**Rotation 3 (Sept./Oct.)**		
Reach			**Reach**		
1	3.0- 0.7	05/27	1	3.0-0.7	09/30
2	14.0-13.5	05/04	2	10.0-9.5	09/21
	13.0- 9.0	05/04		9.5-5.0	09/22
	9.0- 8.5	05/04		5.0-4.5	09/22
3	27.0-26.5	05/03	3	24.0-23.5	09/20
	26.5-22.0	05/03		23.5-19.0	09/20
	22.0-21.5	05/04		19.0-18.5	09/21
4	37.0-36.5	04/27	4	42.0-41.5	10/05
	36.5-32.0	04/28		41.5-37.0	10/06
	32.0-31.5	04/28		37.0-36.5	10/06
5	49.0-48.5	04/26	5	52.0-51.5	10/04
	48.5-44.0	04/26		51.5-47.0	10/04
	44.0-43.5	04/27		47.0-46.5	10/05
	59.9-57.0	05/13		59.9-57.0	09/29
6	66.9-60.0	05/14	6	60.0-66.9	09/28
7	67.0-74.9	N/S[b]	7	67.0-74.9	N/S
Rotation 2 (June/July)					
Reach					
1	3.0- 0.7	06/29			
2	12.0-11.5	07/28			
	11.5- 7.0	07/29			
	7.0- 6.5	07/29			
3	21.0-20.5	07/27			
	20.5-16.0	07/27			
	16.0-15.5	07/28			
4	38.0-37.5	07/14			
	37.5-33.0	07/14			
	33.0-32.5	07/14			
5	55.0-54.5	07/12			
	54.5-50.0	07/13			
	50.0-49.5	07/13			
	59.9-57.0	06/30			
6	66.9-60.0	07/07			
7	66.9-74.9	07/06			

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[a] MM/DD = month and day.

[b] N/S = stream reach not sampled.

APPENDIX D

Size Groupings for Young-of-the-Year, Juvenile and Adult Fishes for the 19 Fish Species Collected During the Gunnison River Ichthyofaunal Survey

Table D.1. Size groupings (total length, mm) by three age categories (YOY = young-of-the-year, JUV = juvenile, and adult) for 19 fish species collected by electrofishing from the Gunnison River, Colorado, 1992-1993. See Appendix A; Table A.1. for the definition of the two-letter species fish code.

YOY	Total	JUV	Total	Adult	Total
BH<60		60-300		>300	
FM<60		60-410		>410	
RZ<60		60-400		>400	
WS<60		60-300		>300	
CP<70		70-250		>250	
CS<60		60-400		>400	
FH<20		20-35		>35	
HB<55		55-260		>260	
RS<20		20-30		>30	
RT<55		55-260		>260	
SS<20		20-30		>30	
SD<20		20-32		>32	
BB<50		52-250		>250	
CC<60		60-300		>300	
NP<100		100-500		>500	
RB<100		100-250		>250	
BN<100		100-250		>250	
GS<45		45-210		>210	
LG<50		50-250		>250	

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APPENDIX E

Catch Statistics for Fishes Collected by Electrofishing During 1992: Reaches 1-7 Combined; Reaches 1-7 Separately

Table E.1. Catch statistics for fishes collected by electrofishing from the Colorado/Gunnison River confluence upstream to the North Fork River confluence, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reaches 1-7 (River Mile: 0.7-74.9)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	83	379	462	0.78	3.54	1.10	5.04	6	6	30	69
brown trout	166	288	454	1.56	2.20	2.21	3.83	5	7	50	90
northern pike	0	9	9	–	0.08	–	0.12	–	13	0	7
common carp	56	1,309	1,365	0.52	12.23	0.74	17.41	7	3	29	135
roundtail chub	1,866	1,204	3,070	17.48	11.25	24.82	16.01	3	4	161	161
Colorado squawfish	0	3	3	–	0.03	–	0.04	–	14	0	3
speckled dace	14	139	153	0.13	1.30	0.19	1.85	9	9	9	67
longnose sucker	1	0	1	0.01	–	0.01	–	14	–	1	0
white sucker	472	939	1,411	4.42	8.77	6.28	12.49	4	5	90	127
bluehead sucker	4,402	3,526	7,928	41.24	32.95	58.55	46.90	1	1	177	179
flannelmouth sucker	3,530	2,626	6,156	33.07	24.54	46.95	34.93	2	2	186	182
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	6	3	9	0.06	0.03	0.08	0.04	12	14	4	3
channel catfish	5	16	21	0.05	0.15	0.07	0.21	13	12	3	7
green sunfish	12	3	15	0.11	0.03	0.16	0.04	12	14	6	3
smallmouth bass	1	0	1	0.01	–	0.01	–	14	–	1	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	18	18	–	0.17	–	0.24	–	11	0	12
Hybrids											
bluehead sucker X flannelmouth sucker	1	11	12	0.01	0.10	0.16	0.15	11	13	1	7
white sucker X bluehead sucker	27	151	178	0.25	1.41	0.36	2.01	8	8	23	44
white sucker X flannelmouth sucker	13	85	98	0.12	0.79	0.17	1.13	10	10	10	39
TOTAL	10,655	10,709	21,364	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reaches 1-7.

[b] Number of samples: 193.

[c] Percent of the total number of juvenile (JUV) fishes in all reaches.

[d] Percent of the total number of adult (ADU) fishes in all reaches.

Total hours sampled: 75.182.

Total river miles sampled: 195.6.

Table E.2. Catch statistics for fishes collected by electrofishing from the Colorado and Gunnison River confluence to Redlands Diversion Dam, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 1 (River Mile: 0.7-3.0)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	0	2	2	–	0.34	–	0.56	–	9	0	2
brown trout	2	9	11	0.36	1.52	0.56	2.53	7	7	1	4
northern pike	0	1	1	–	0.17	–	0.28	–	11	0	1
common carp	18	196	214	3.28	33.16	5.06	55.09	4	1	6	11
roundtail chub	56	66	122	10.22	11.17	15.74	18.55	3	4	10	11
Colorado squawfish	0	3	3	–	0.51	–	0.84	–	8	0	3
speckled dace	0	1	1	–	0.17	–	0.28	–	11	0	1
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	6	22	28	1.09	3.72	1.68	6.18	5	5	3	5
bluehead sucker	70	124	194	12.79	20.78	19.67	34.85	2	3	9	11
flannelmouth sucker	386	147	533	70.44	24.87	10.85	41.32	1	2	11	9
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	1	2	3	0.18	0.34	0.28	0.34	8	10	1	2
channel catfish	5	15	20	0.91	2.54	1.41	4.22	6	6	3	6
green sunfish	2	0	2	0.36	–	0.56	–	7	–	1	0
smallmouth bass	1	0	1	0.18	–	0.28	–	8	–	1	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	1	2	3	0.18	0.34	0.28	0.56	8	9	1	2
white sucker X flannelmouth sucker	0	1	1	–	0.17	–	0.28	-	11	0	1
TOTAL	548	591	1,139	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 1.

[b] Number of samples: 11.

[c] Percent of the total number of juvenile (JUV) fishes in reach 1.

[d] Percent of the total number of adult (ADU) fishes in reach 1.

Total hours sampled: 3.558.

Total river miles sampled: 10.2.

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Table E.3. Catch statistics for fishes collected by electrofishing from Redlands Diversion Dam to Whitewater, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 2 (River Mile: 3.1-15.0)

Common Name	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	2	10	12	0.09	0.94	0.13	0.67	6	8	2	6
brown trout	2	16	18	0.09	1.50	0.13	1.08	6	7	2	10
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	10	201	211	0.43	18.86	0.67	13.55	5	4	7	24
roundtail chub	734	312	1,046	31.57	29.27	49.47	21.03	2	1	36	35
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	1	20	21	0.04	1.88	0.07	1.35	7	6	1	11
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	12	25	37	0.52	2.35	0.81	1.68	4	5	9	14
bluehead sucker	1,050	237	1,287	45.16	22.23	70.76	15.97	1	3	34	31
flannelmouth sucker	512	238	750	22.02	22.33	34.51	16.04	3	2	34	33
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	1	1	–	0.09	–	0.07	–	10	0	1
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	1	3	4	0.04	0.28	0.07	0.20	7	9	1	3
white sucker X flannelmouth sucker	1	3	4	0.04	0.28	0.07	0.20	7	9	1	3
TOTAL	2,325	1,066	3,391	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 2.

[b] Number of samples: 37.

[c] Percent of the total number of juvenile (JUV) fishes in reach 2.

[d] Percent of the total number of adult (ADU) fishes in reach 2.

Total hours sampled: 14.838.

Total river miles sampled: 33.0.

Table E.4. Catch statistics for fishes collected by electrofishing from Whitewater to Bridgeport, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 3 (River Mile: 15.1-30.0)

Common Name	Number of Fish JUV	Number of Fish ADU	Number of Fish TOTAL	Percentage Composition JUV[c]	Percentage Composition ADU[d]	CPUE[a] (Fish/Hour) JUV	CPUE[a] (Fish/Hour) ADU	Ranked CPUE[a] JUV	Ranked CPUE[a] ADU	Frequency of Occurrence in Samples[b] JUV	Frequency of Occurrence in Samples[b] ADU
rainbow trout	0	10	10	–	0.76	–	0.68	–	9	0	8
brown trout	10	18	28	0.43	1.37	0.68	1.22	6	7	8	13
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	20	183	203	0.85	13.84	1.35	12.39	4	4	4	26
roundtail chub	476	333	809	20.32	25.19	32.24	22.55	3	3	34	34
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	3	28	31	0.12	2.12	0.20	1.89	8	6	2	15
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	19	35	54	0.82	2.65	1.29	2.37	5	5	10	21
bluehead sucker	976	263	1,239	41.66	19.89	66.10	17.81	1	2	34	32
flannelmouth sucker	832	434	1,266	35.51	32.83	56.35	29.39	2	1	34	34
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	1	1	–	0.08	–	0.07	–	12	0	1
green sunfish	1	2	3	0.04	0.15	0.07	0.14	9	11	1	2
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	5	3	8	0.21	0.23	0.34	0.20	7	10	5	2
white sucker X flannelmouth sucker	0	12	12	–	0.91	–	0.81	–	8	0	11
TOTAL	2,342	1,322	3,664	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 3.

[b] Number of samples: 34.

[c] Percent of the total number of juvenile (JUV) fishes in reach 3.

[d] Percent of the total number of adult (ADU) fishes in reach 3.

Total hours sampled: 14.766.

Total river miles sampled: 33.0.

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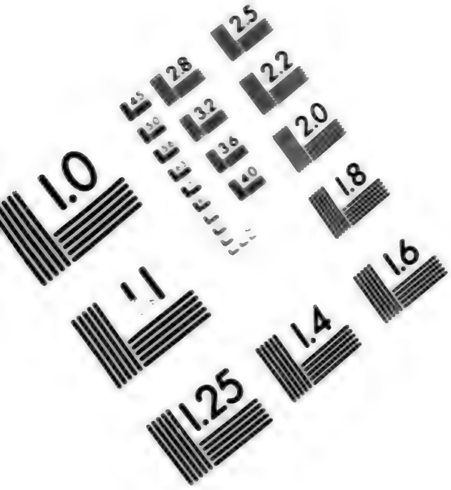

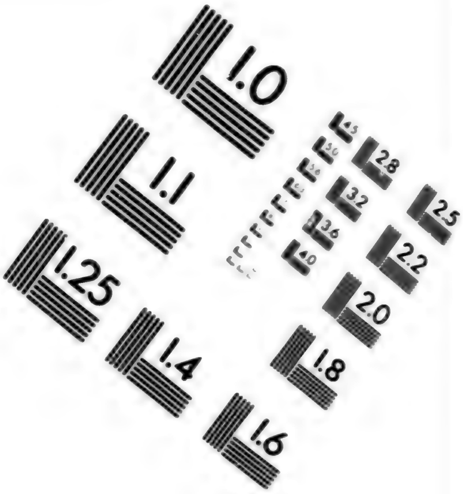

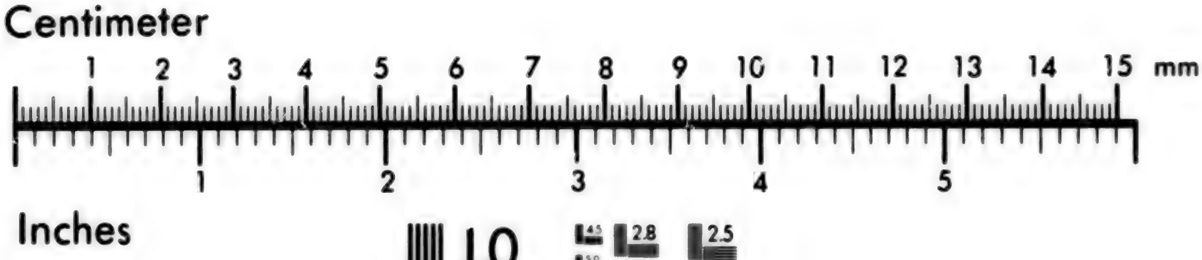

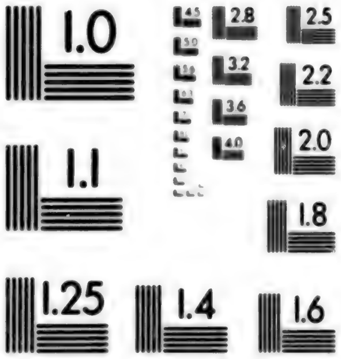

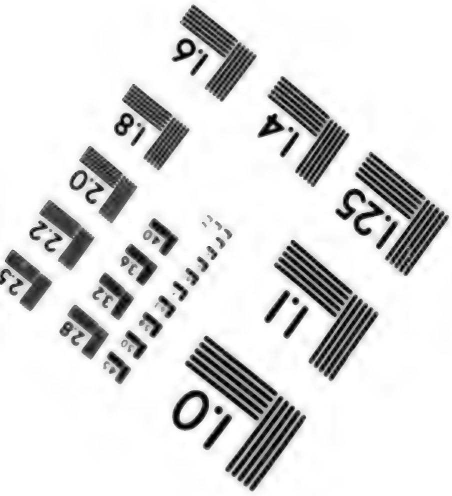

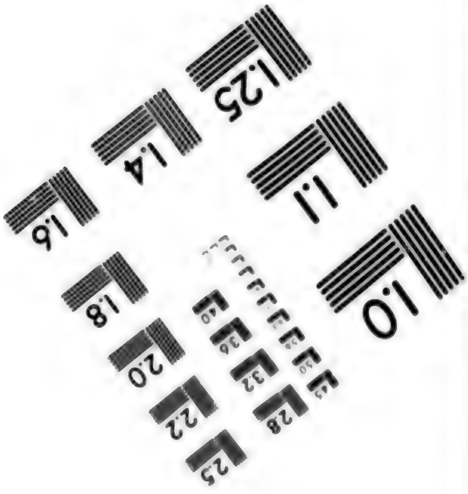

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Table E.5. Catch statistics for fishes collected by electrofishing from Bridgeport to Escalante Bridge, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 4 (River Mile: 30.1-42.0)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	0	11	11	–	0.80	–	0.82	–	8	0	6
brown trout	4	19	23	0.22	1.38	0.30	1.42	5	6	3	13
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	1	95	96	0.06	6.92	0.07	7.12	8	4	1	14
roundtail chub	261	267	528	14.63	19.46	19.57	20.02	3	3	29	32
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	1	7	8	0.06	0.51	0.07	0.52	8	9	1	7
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	7	38	45	0.39	2.77	0.52	2.85	4	5	12	22
bluehead sucker	887	442	1,329	49.72	32.22	66.50	33.14	1	2	31	31
flannelmouth sucker	616	476	1,092	34.53	34.69	46.18	35.68	2	1	32	32
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	2	0	2	0.11	–	0.15	–	7	–	1	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	0	2	2	–	0.22	–	0.15	–	11	0	1
white sucker X bluehead sucker	2	14	16	0.11	1.02	0.15	1.05	7	7	2	7
white sucker X flannelmouth sucker	3	3	6	0.17	0.22	0.22	0.22	6	10	3	1
TOTAL	1,784	1,374	3,158	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 4.

[b] Number of samples: 32.

[c] Percent of the total number of juvenile (JUV) fishes in reach 4.

[d] Percent of the total number of adult (ADU) fishes in reach 4.

Total hours sampled: 13.339.

Total river miles sampled: 39.5.

Table E.6. Catch statistics for fishes collected by electrofishing from Escalante Bridge to Hartland Diversion Dam, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 5 (River Mile: 42.1-59.9)

Common Name	Number of Fish JUV	Number of Fish ADU	Number of Fish TOTAL	Percentage Composition JUV[c]	Percentage Composition ADU[d]	CPUE[a] (Fish/Hour) JUV	CPUE[a] (Fish/Hour) ADU	Ranked CPUE[a] JUV	Ranked CPUE[a] ADU	Frequency of Occurrence in Samples[b] JUV	Frequency of Occurrence in Samples[b] ADU
rainbow trout	8	57	65	0.26	1.55	0.43	3.07	8	7	7	21
brown trout	20	52	72	0.66	1.41	1.08	2.80	6	8	15	25
northern pike	0	8	8	–	0.22	–	0.43	10	11	0	6
common carp	24	491	515	0.79	13.35	1.29	26.41	5	3	10	39
roundtail chub	299	221	520	9.90	6.01	16.09	11.89	3	5	41	44
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	7	35	42	0.23	0.95	0.38	1.88	9	6	3	20
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	249	387	636	8.24	10.52	13.40	20.82	4	4	32	39
bluehead sucker	1,307	1,611	2,918	43.26	43.81	70.31	86.67	1	1	48	48
flannelmouth sucker	1,072	786	1,858	35.48	21.38	57.67	42.28	2	2	52	48
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	5	1	6	0.2	0.17	0.27	0.05	12	12	3	1
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	7	0	7	0.23	–	0.38	–	9	–	3	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	1	1	–	0.03	–	0.05	–	12	0	1
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	15	16	31	0.50	0.44	0.81	0.86	7	9	11	9
white sucker X flannelmouth sucker	8	11	19	0.26	0.30	0.43	0.59	8	10	5	6
TOTAL	3,021	3,677	6,698	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 5.

[b] Number of samples: 53.

[c] Percent of the total number of juvenile (JUV) fishes in reach 5.

[d] Percent of the total number of adult (ADU) fishes in reach 5.

Total hours sampled: 18.588.

Total river miles sampled: 50.1.

Table E.7. Catch statistics for fishes collected by electrofishing from Hartland Diversion Dam to Austin, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 6 (River Mile: 60.0-66.9)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	33	136	169	7.33	8.44	6.06	24.96	6	4	11	15
brown trout	53	73	126	11.78	4.53	9.73	13.40	4	6	11	14
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	1	131	132	0.22	8.13	0.18	24.04	9	5	1	15
roundtail chub	39	2	41	8.67	0.12	7.16	0.37	5	10	10	2
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	2	40	42	0.44	2.48	0.37	7.34	8	8	2	8
longnose sucker	1	0	1	0.22	–	0.18	–	9	–	1	0
white sucker	149	276	425	33.11	17.13	27.34	50.65	1	3	15	15
bluehead sucker	85	544	629	18.89	33.77	15.60	99.83	2	1	12	15
flannelmouth sucker	83	302	385	18.44	18.75	15.23	55.42	3	2	13	15
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	6	6	–	0.37	–	1.10	–	9	0	5
Hybrids											
bluehead sucker X flannelmouth sucker	1	2	3	0.22	0.12	0.18	0.37	9	10	1	2
white sucker X bluehead sucker	3	59	62	0.67	3.67	0.55	10.83	7	7	3	10
white sucker X flannelmouth sucker	0	40	40	–	2.48	–	7.34	–	8	0	9
TOTAL	450	1,611	2,061	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 6.

[b] Number of samples: 15.

[c] Percent of the total number of juvenile (JUV) fishes in reach 6.

[d] Percent of the total number of adult (ADU) fishes in reach 6.

Total hours sampled: 5.449.

Total river miles sampled: 16.0.

Table E.8. Catch statistics for fishes collected by electrofishing from Austin to the Gunnison and North Fork river confluence, Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled.

Reach 7 (River Mile: 67.0-74.9)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	40	153	193	19.70	14.43	8.61	32.95	2	4	10	11
brown trout	75	101	176	36.95	9.53	16.15	21.75	1	5	10	11
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	0	12	12	–	1.13	–	2.58	–	8	0	6
roundtail chub	1	3	4	0.49	0.28	0.22	0.65	6	12	1	3
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	0	8	8	–	0.75	–	1.72	–	10	0	5
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	30	156	186	14.78	14.72	6.46	33.59	3	3	9	11
bluehead sucker	27	305	332	13.30	28.77	5.81	65.68	5	1	9	11
flannelmouth sucker	29	243	272	14.29	22.92	6.24	52.33	4	2	10	11
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	11	11	–	1.04	–	2.37	–	9	0	7
Hybrids											
bluehead sucker X flannelmouth sucker	0	7	7	–	0.66	–	1.50	–	11	0	4
white sucker X bluehead sucker	0	54	54	–	5.09	–	11.63	–	6	0	11
white sucker X flannelmouth sucker	1	15	16	0.49	1.42	0.22	3.23	6	7	1	8
TOTAL	203	1,060	1,263	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 7.
[b] Number of samples: 11.
[c] Percent of the total number of juvenile (JUV) fishes in reach 7.
[d] Percent of the total number of adult (ADU) fishes in reach 7.
Total hours sampled: 4.644.
Total river miles sampled: 13.8.

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APPENDIX F

Catch Statistics for Fishes Collected by Electrofishing During 1993: Reaches 1-7 Combined; Reaches 1-7 Separately

Table F.1. Catch statistics for fishes collected by electrofishing from the Colorado/Gunnison River confluence upstream to the North Fork River confluence, Gunnison River, Colorado, 1993. Note: April/May, July, and October collections were pooled.

Reaches 1-7 (River Mile: 0.7-74.9)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	46	269	315	0.90	3.16	0.71	4.14	7	6	17	32
brown trout	166	258	424	3.26	3.03	2.55	3.97	4	7	50	58
northern pike	0	5	5	–	0.06	–	0.08	–	13	0	5
common carp	7	1,080	1,087	0.14	12.67	0.11	16.61	8	3	2	110
roundtail chub	1,025	963	1,988	20.12	11.30	15.76	14.81	3	4	117	125
humpback chub	1	0	1	0.02	–	0.02	–	12	–	1	0
Colorado squawfish	0	6	6	–	0.07	–	0.09	–	12	0	5
speckled dace	3	60	63	0.06	0.70	0.05	0.92	11	10	2	25
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	120	598	718	2.36	7.01	1.85	9.20	5	5	48	86
bluehead sucker	1,729	2,818	4,547	33.94	33.06	26.59	43.34	2	1	133	126
flannelmouth sucker	1,808	2,061	3,869	35.49	24.18	27.81	31.70	1	2	140	142
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	1	1	2	0.02	0.01	0.02	0.02	12	15	1	1
channel catfish	1	0	1	0.02	–	0.02	–	12	–	1	0
green sunfish	5	1	6	0.10	0.01	0.08	0.02	10	15	3	1
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	1	1	–	0.01	–	0.02	–	15	0	1
mottled sculpin	0	4	4	–	0.05	–	0.06	–	14	0	4
Hybrids											
bluehead sucker X flannelmouth sucker	6	7	13	0.12	0.08	0.09	0.11	9	11	5	7
white sucker X bluehead sucker	120	196	316	2.36	2.06	1.85	2.71	5	9	25	47
white sucker X flannelmouth sucker	58	197	255	1.14	2.31	0.89	3.03	6	8	35	40
TOTAL	5,096	8,525	13,621	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reaches 1-7.

[b] Number of samples: 150.

[c] Percent of the total number of juvenile (JUV) fishes in all reaches.

[d] Percent of the total number of adult (ADU) fishes in all reaches.

Total hours sampled: 65.023.

Total river miles sampled: 172.0.

Table F.2. Catch statistics for fishes collected by electrofishing from the Colorado and Gunnison River confluence to Redlands Diversion Dam, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 1 (River Mile: 0.7-3.0)

Common Name	Number of Fish JUV	 ADU	 TOTAL	Percentage Composition JUV[c]	 ADU[d]	CPUE[a] (Fish/Hour) JUV	 ADU	Ranked CPUE[a] JUV	 ADU	Frequency of Occurrence in Samples[b] JUV	 ADU
rainbow trout	0	1	1	–	0.15	–	0.28	–	8	0	1
brown trout	0	3	3	–	0.45	–	0.87	–	6	0	2
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	0	198	198	–	29.73	–	57.11	–	2	0	8
roundtail chub	47	92	139	9.85	13.81	13.56	26.54	3	4	7	8
Colorado squawfish	0	1	1	–	0.15	–	0.28	–	8	0	1
speckled dace	0	3	3	–	0.45	–	0.87	–	6	0	3
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	1	9	10	0.21	1.35	0.28	2.60	5	5	1	5
bluehead sucker	142	249	391	29.77	37.39	40.96	71.82	2	1	7	8
flannelmouth sucker	282	106	388	59.12	15.92	81.34	30.57	1	3	8	8
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	1	0	1	0.21	–	0.28	–	5	–	1	0
channel catfish	1	0	1	0.21	–	0.28	–	5	–	1	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	1	1	–	0.15	–	0.28	–	8	0	1
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	1	1	2	0.21	0.15	0.28	0.28	5	8	1	1
white sucker X bluehead sucker	2	2	4	0.42	0.30	0.56	0.56	4	7	2	1
white sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
TOTAL	477	666	1,143	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 1.

[b] Number of samples: 8.

[c] Percent of the total number of juvenile (JUV) fishes in reach 1.

[d] Percent of the total number of adult (ADU) fishes in reach 1.

Total hours sampled: 3.467.

Total river miles sampled: 8.1.

Table F.3. Catch statistics for fishes collected by electrofishing from Redlands Diversion Dam to Whitewater, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 2 (River Mile: 3.1-15.0)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	0	2	2	–	0.32	–	0.14	–	8	0	2
brown trout	11	2	13	1.57	0.32	0.76	0.14	4	8	7	2
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	0	122	122	–	19.71	–	8.46	–	2	0	19
roundtail chub	361	257	618	51.65	41.52	25.02	17.81	1	1	26	23
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	2	29	31	0.29	4.68	0.14	2.01	5	5	1	8
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	0	9	9	–	1.45	–	0.62	–	6	0	6
bluehead sucker	210	83	293	30.04	13.41	14.55	5.75	2	4	23	19
flannelmouth sucker	113	110	223	16.17	17.77	7.83	7.62	3	3	24	22
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	0	2	2	–	0.32	–	0.14	–	8	0	2
white sucker X flannelmouth sucker	2	3	5	0.29	0.48	0.14	0.21	5	7	2	2
TOTAL	699	619	1,318	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 2.

[b] Number of samples: 28.

[c] Percent of the total number of juvenile (JUV) fishes in reach 2.

[d] Percent of the total number of adult (ADU) fishes in reach 2.

Total hours sampled: 14.429.

Total river miles sampled: 33.0.

Table F.4. Catch statistics for juvenile and adult fishes collected by electrofishing from Whitewater to Bridgeport, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 3 (River Mile: 15.1-30.0)

Common Name	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	0	0	0	–	–	–	–	–	–	0	0
brown trout	8	13	21	0.83	1.55	0.59	0.95	7	6	6	9
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	6	124	130	0.62	14.80	0.44	9.09	8	3	1	18
roundtail chub	339	253	592	35.28	30.19	24.85	18.55	1	2	24	25
humpback chub	1	0	1	0.10	–	0.07	–	9	–	1	0
Colorado squawfish	0	2	2	–	0.24	–	0.15	–	10	0	2
speckled dace	0	9	9	–	1.07	–	0.66	–	8	0	4
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	14	17	31	1.46	2.03	1.03	1.25	5	5	10	12
bluehead sucker	270	103	373	28.10	12.30	19.79	7.55	3	4	26	20
flannelmouth sucker	310	310	620	32.26	36.99	22.73	22.73	2	1	28	28
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	1	1	–	0.12	–	0.07	–	11	0	1
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	1	1	2	0.10	0.12	0.07	0.07	9	11	1	1
white sucker X bluehead sucker	0	2	2	–	0.24	–	0.88	–	7	0	2
white sucker X flannelmouth sucker	12	3	15	1.25	0.36	0.88	0.22	6	9	3	3
TOTAL	961	838	1,799	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 3.

[b] Number of samples: 29.

[c] Percent of the total number of juvenile (JUV) fishes in reach 3.

[d] Percent of the total number of adult (ADU) fishes in reach 3.

Total hours sampled: 13.640.

Total river miles sampled: 33.0.

Table F.5. Catch statistics for fishes collected by electrofishing from Bridgeport to Escalante Bridge, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 4 (River Mile: 30.1-42.0)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	2	3	5	0.20	0.22	0.17	0.26	8	9	2	3
brown trout	10	16	26	1.02	1.20	0.85	1.36	4	6	7	11
northern pike	0	0	0	–	–	–	–	–	–	0	0
common carp	0	131	131	–	9.80	–	11.15	–	4	0	17
roundtail chub	128	174	302	13.06	13.01	10.90	14.81	3	3	23	27
Colorado squawfish	0	3	3	–	0.22	–	0.26	–	9	0	2
speckled dace	0	1	1	–	0.07	–	0.09	–	10	0	1
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	4	38	42	0.41	2.84	0.34	3.24	6	5	3	16
bluehead sucker	438	500	938	44.69	37.40	37.29	42.57	1	1	25	23
flannelmouth sucker	386	444	830	39.39	33.21	32.87	37.80	2	2	27	28
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	1	1	–	0.07	–	0.09	–	10	0	1
Hybrids											
bluehead sucker X flannelmouth sucker	3	3	6	0.31	0.22	0.26	0.26	7	9	2	3
white sucker X bluehead sucker	2	15	17	0.20	1.12	0.17	1.28	8	7	2	11
white sucker X flannelmouth sucker	7	8	15	0.71	0.61	0.60	0.68	5	8	4	6
TOTAL	980	1,337	2,317	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 4.

[b] Number of samples: 28.

[c] Percent of the total number of juvenile (JUV) fishes in reach 4.

[d] Percent of the total number of adult (ADU) fishes in reach 4.

Total hours sampled: 11.745.

Total river miles sampled: 33.0.

Table F.6. Catch statistics for fishes collected by electrofishing from Escalante Brdige to Hartland Diversion Dam, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 5 (River Mile: 42.1-59.5)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	4	43	47	0.25	1.47	0.27	2.87	9	6	4	14
brown trout	30	33	63	1.89	1.12	2.01	2.21	5	9	15	19
northern pike	0	2	2	–	0.07	–	0.13	–	11	0	2
common carp	0	338	338	–	11.52	–	22.60	–	3	0	33
roundtail chub	145	179	324	9.13	6.10	9.69	11.97	3	5	32	36
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	1	17	18	0.06	0.58	0.07	1.14	10	10	1	8
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	68	190	258	4.28	6.48	4.55	12.70	4	4	21	32
bluehead sucker	615	1,385	2,000	38.70	47.19	41.11	92.60	2	1	41	41
flannelmouth sucker	672	663	1,335	42.29	22.59	44.93	44.33	1	2	42	41
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	5	1	6	0.31	0.03	0.33	0.07	8	12	3	1
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	0	0	–	–	–	–	–	–	0	0
Hybrids											
bluehead sucker X flannelmouth sucker	1	1	2	0.06	0.03	0.07	0.07	10	12	1	1
white sucker X bluehead sucker	20	42	62	1.26	1.43	1.34	2.81	7	7	13	16
white sucker X flannelmouth sucker	28	41	69	1.76	1.40	1.87	2.74	6	8	22	18
TOTAL	1,589	2,935	4,524	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 5.

[b] Number of samples: 42.

[c] Percent of the total number of juvenile (JUV) fishes in reach 5.

[d] Percent of the total number of adult (ADU) fishes in reach 5.

Total hours sampled: 14.957.

Total river miles sampled: 41.0.

Table F.7. Catch statistics for fishes collected by electrofishing from Hartland Diversion Dam to Austin, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 6 (River Mile: 60.0-66.9)

	Number of Fish			Percentage Composition		CPUE[a] (Fish/Hour)		Ranked CPUE[a]		Frequency of Occurrence in Samples[b]	
Common Name	JUV	ADU	TOTAL	JUV[c]	ADU[d]	JUV	ADU	JUV	ADU	JUV	ADU
rainbow trout	12	121	133	4.40	8.97	2.58	25.98	6	4	6	10
brown trout	48	78	126	17.58	5.78	10.30	16.75	2	6	10	10
northern pike	0	2	2	–	0.15	–	0.43	–	9	0	2
common carp	1	121	122	0.37	8.97	0.21	25.98	9	4	1	10
roundtail chub	4	7	11	1.47	0.52	0.86	1.50	8	8	4	5
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	0	1	1	–	0.07	–	0.21	–	10	0	1
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	29	189	218	10.62	14.01	6.23	40.58	5	3	9	10
bluehead sucker	42	365	407	15.38	27.06	9.02	78.36	3	1	8	10
flannelmouth sucker	36	311	347	13.19	23.05	7.73	66.77	4	2	8	10
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	2	2	–	0.15	–	0.43	–	9	0	2
Hybrids											
bluehead sucker X flannelmouth sucker	0	1	1	–	0.07	–	0.21	–	10	0	1
white sucker X bluehead sucker	93	80	173	34.07	5.93	19.97	17.17	1	5	6	10
white sucker X flannelmouth sucker	8	71	79	2.93	5.26	1.72	15.24	7	7	3	10
TOTAL	273	1,349	1,622	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 6.

[b] Number of samples: 10.

[c] Percent of the total number of juvenile (JUV) fishes in reach 6.

[d] Percent of the total number of adult (ADU) fishes in reach 6.

Total hours sampled: 4.658.

Total river miles sampled: 15.6.

Table F.8. Catch statistics for fishes collected by electrofishing from Austin to the Gunnison and North Fork river confluence, Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

Reach 7 (River Mile: 67.0-74.9)

Common Name	Number of Fish JUV	Number of Fish ADU	Number of Fish TOTAL	Percentage Composition JUV[c]	Percentage Composition ADU[d]	CPUE[a] (Fish/Hour) JUV	CPUE[a] (Fish/Hour) ADU	Ranked CPUE[a] JUV	Ranked CPUE[a] ADU	Frequency of Occurrence in Samples[b] JUV	Frequency of Occurrence in Samples[b] ADU
rainbow trout	28	99	127	23.93	12.68	11.26	39.81	2	5	5	5
brown trout	59	113	172	50.43	14.47	23.72	45.44	1	4	5	5
northern pike	0	1	1	–	0.13	–	0.40	–	9	0	1
common carp	0	46	46	–	5.89	–	18.50	–	8	0	5
roundtail chub	1	1	2	0.85	0.13	0.40	0.40	7	9	1	1
Colorado squawfish	0	0	0	–	–	–	–	–	–	0	0
speckled dace	0	0	0	–	–	–	–	–	–	0	0
longnose sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker	4	146	150	3.42	18.69	1.61	58.71	5	1	4	5
bluehead sucker	12	133	145	10.26	17.03	4.83	53.48	3	2	3	5
flannelmouth sucker	9	117	126	7.69	14.98	3.62	47.04	4	3	3	5
razorback sucker	0	0	0	–	–	–	–	–	–	0	0
black bullhead	0	0	0	–	–	–	–	–	–	0	0
channel catfish	0	0	0	–	–	–	–	–	–	0	0
green sunfish	0	0	0	–	–	–	–	–	–	0	0
smallmouth bass	0	0	0	–	–	–	–	–	–	0	0
largemouth bass	0	0	0	–	–	–	–	–	–	0	0
mottled sculpin	0	1	1	–	0.13	–	0.40	–	9	0	1
Hybrids											
bluehead sucker X flannelmouth sucker	0	0	0	–	–	–	–	–	–	0	0
white sucker X bluehead sucker	3	53	56	2.56	6.79	1.21	21.31	6	7	2	5
white sucker X flannelmouth sucker	1	71	72	0.85	9.10	0.40	28.55	7	6	1	4
TOTAL	117	781	898	–	–	–	–	–	–	–	–

[a] CPUE (total catch per unit of effort) in reach 7.

[b] Number of samples: 5.

[c] Percent of the total number of juvenile (JUV) fishes in reach 7.

[d] Percent of the total number of adult (ADU) fishes in reach 7.

Total hours sampled: 2.487.

Total river miles sampled: 8.3.

APPENDIX G
Captures and Sightings of Juvenile and Adult Colorado Squawfish from the Gunnison River During Previous Fishery Investigations

Table G.1. Captures and sightings of juvenile and adult Colorado squawfish from the Gunnison River, 1979-1981.

RM	Date	Length (mm)	Weight (g)	Research Group/ Agency
Captured downstream of Redlands Diversion Dam				
3.0	79/09/05	566	2,720	FWS-Valdez et al. 1982
3.0	79/09/05	483	451	FWS-Valdez et al. 1982
3.0	79/09/17	622	2,100	FWS-Valdez et al. 1982
3.0	79/09/18	668	2,400	FWS-Valdez et al. 1982
3.0	79/09/18	480	410	FWS-Valdez et al. 1982
3.0	81/05/20	827	5,420	FWS-Valdez et al. 1982
1.5	79/09/18	485	439	FWS-Valdez et al. 1982
1.5	79/09/18	521	470	FWS-Valdez et al. 1982
Captured upstream of Redlands Diversion Dam				
33.8	81/08/25	631	2,270	CDOW
33.0	80/05/20	630	2,420	FWS-Valdez et al. 1982
30.8	81/05/07	798	6,400	FWS-Valdez et al. 1982
26.7	81/08/26	824	6,114	CDOW
Sighted but not captured				
31.4	80/05/20	Adult		FWS-Valdez et al. 1982
27.7	80/05/20	Adult		FWS-Valdez et al. 1982
26.7	81/08/26	Adult		CDOW
22.1	81/07/23	Adult		FWS-Valdez et al. 1982

APPENDIX H

Catch Effort by Species and by Stream Reach for Juvenile and Adult Fishes Collected by Electrofishing, 1992 and 1993

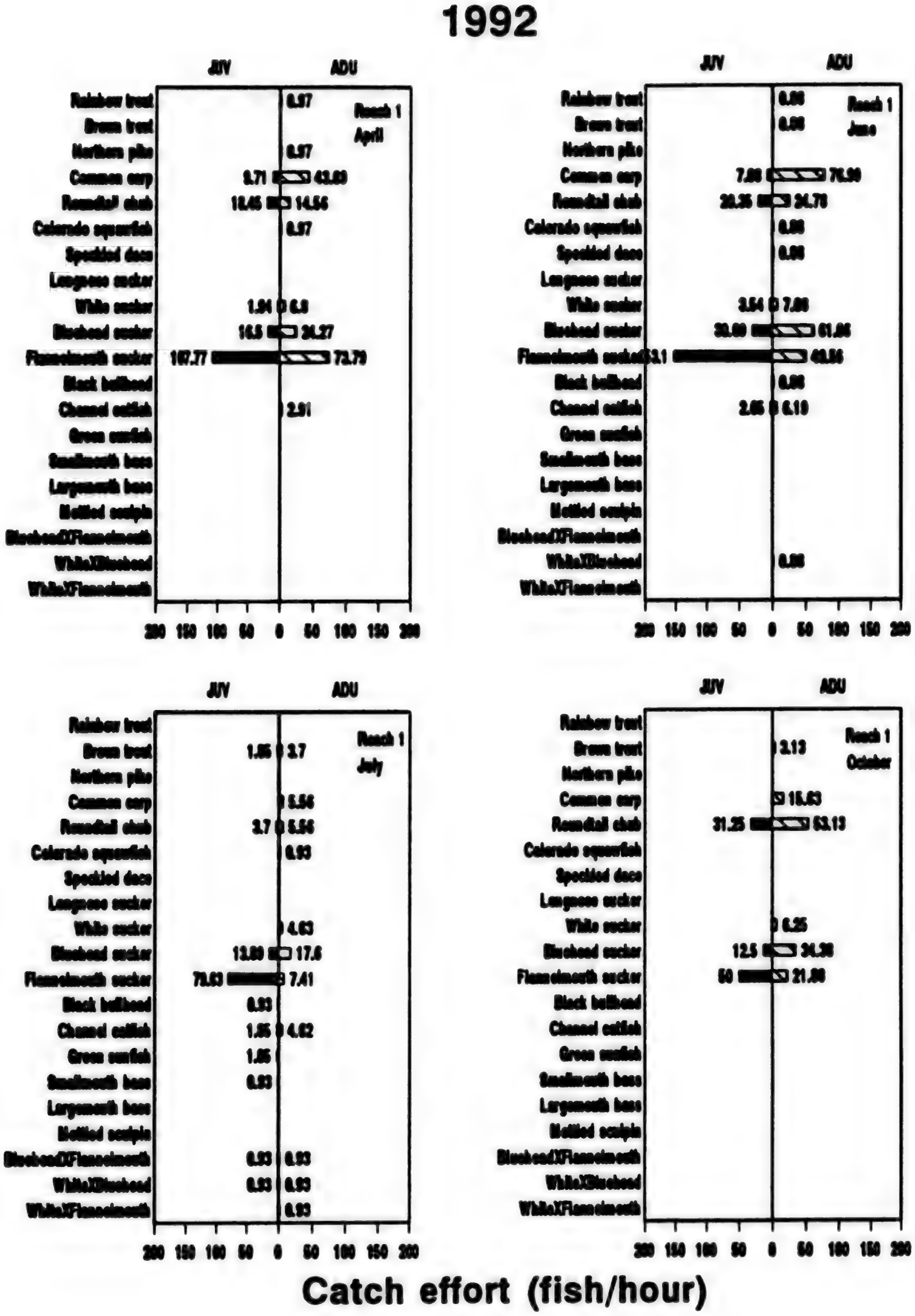

Figure H.1. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 1 of the Gunnison River, Colorado during April, June, July, and October 1992.

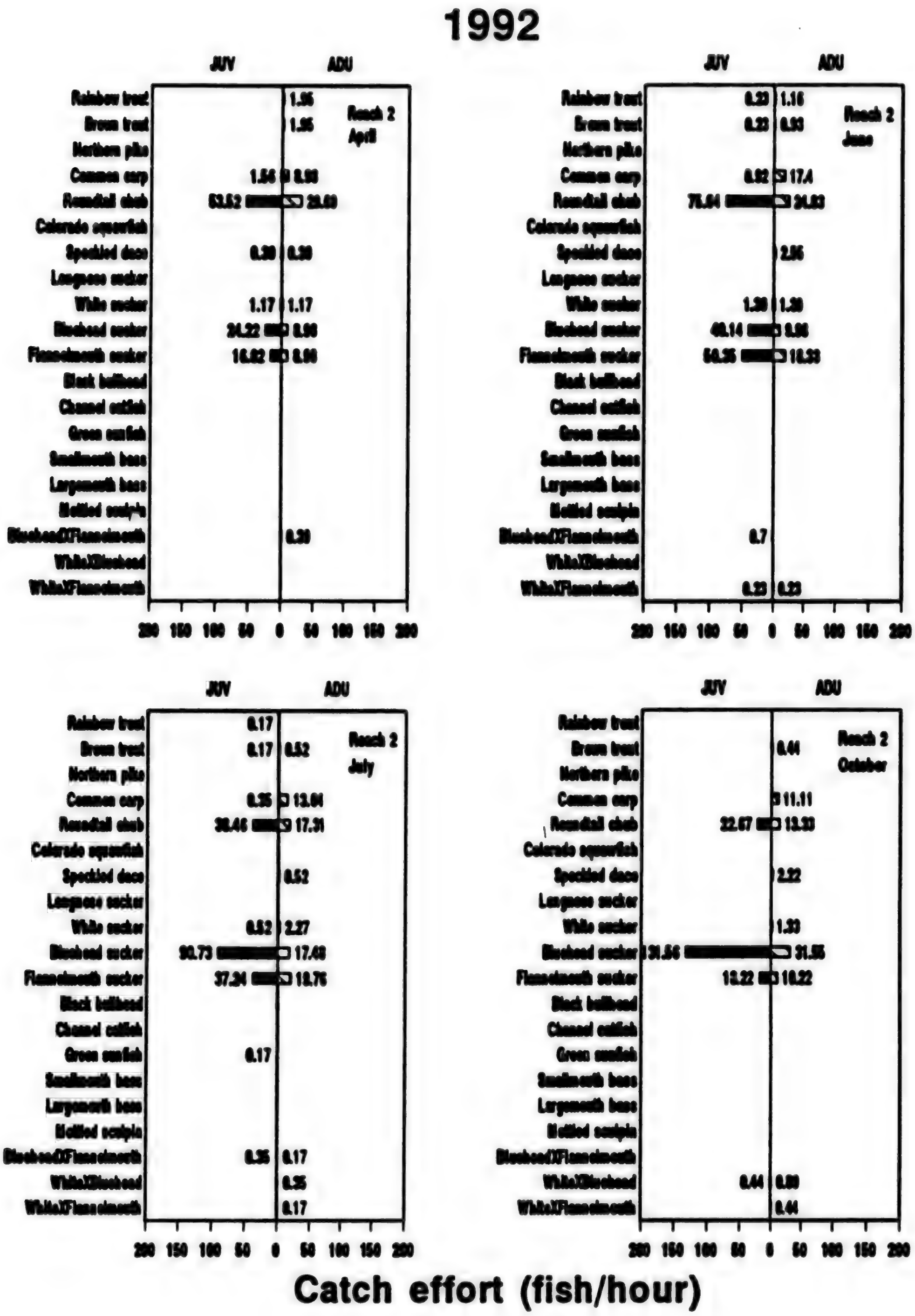

Figure H.2. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 2 of the Gunnison River, Colorado during April, June, July, and October 1992.

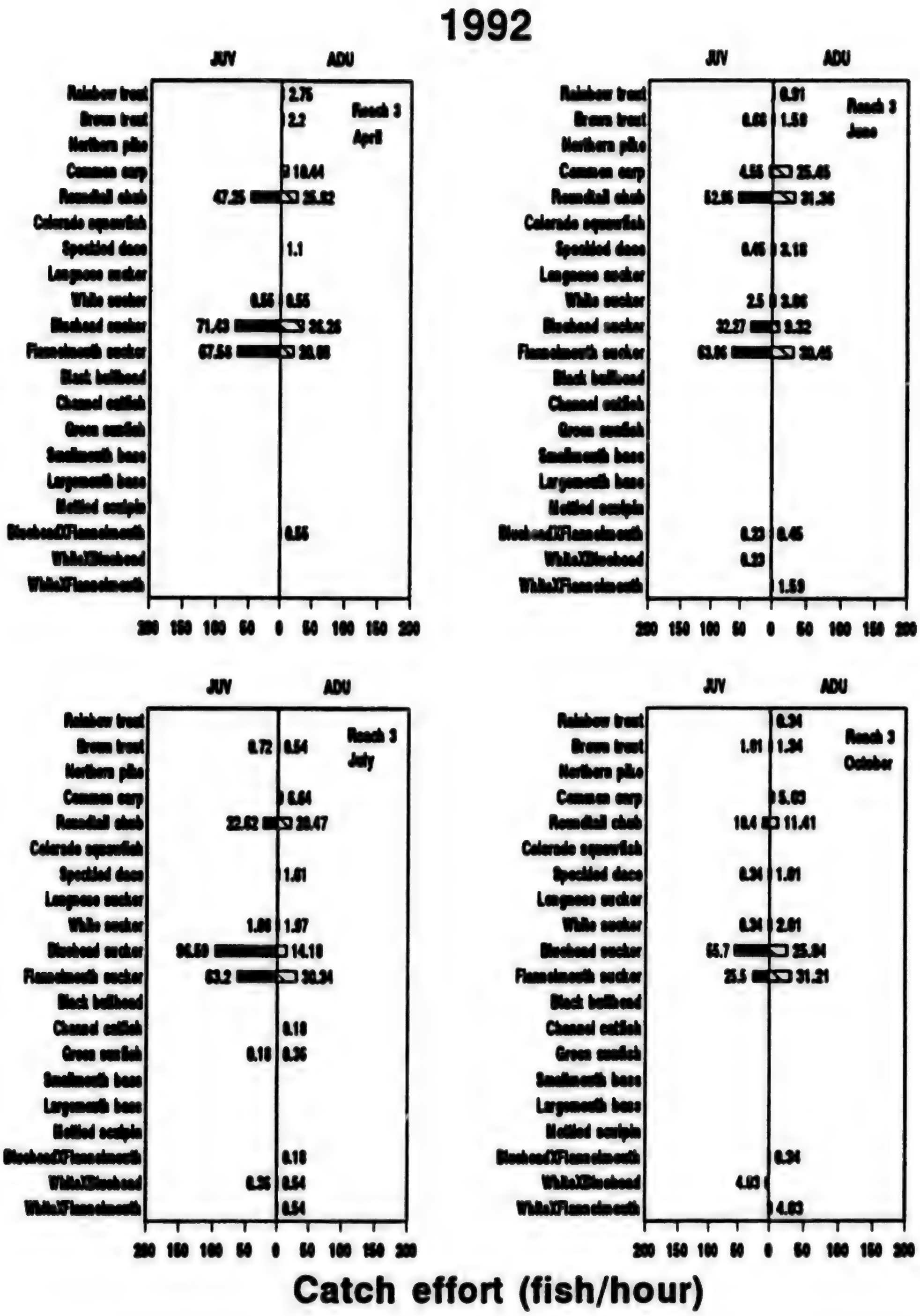

Figure H.3. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 3 of the Gunnison River, Colorado during April, June, July, and October 1992.

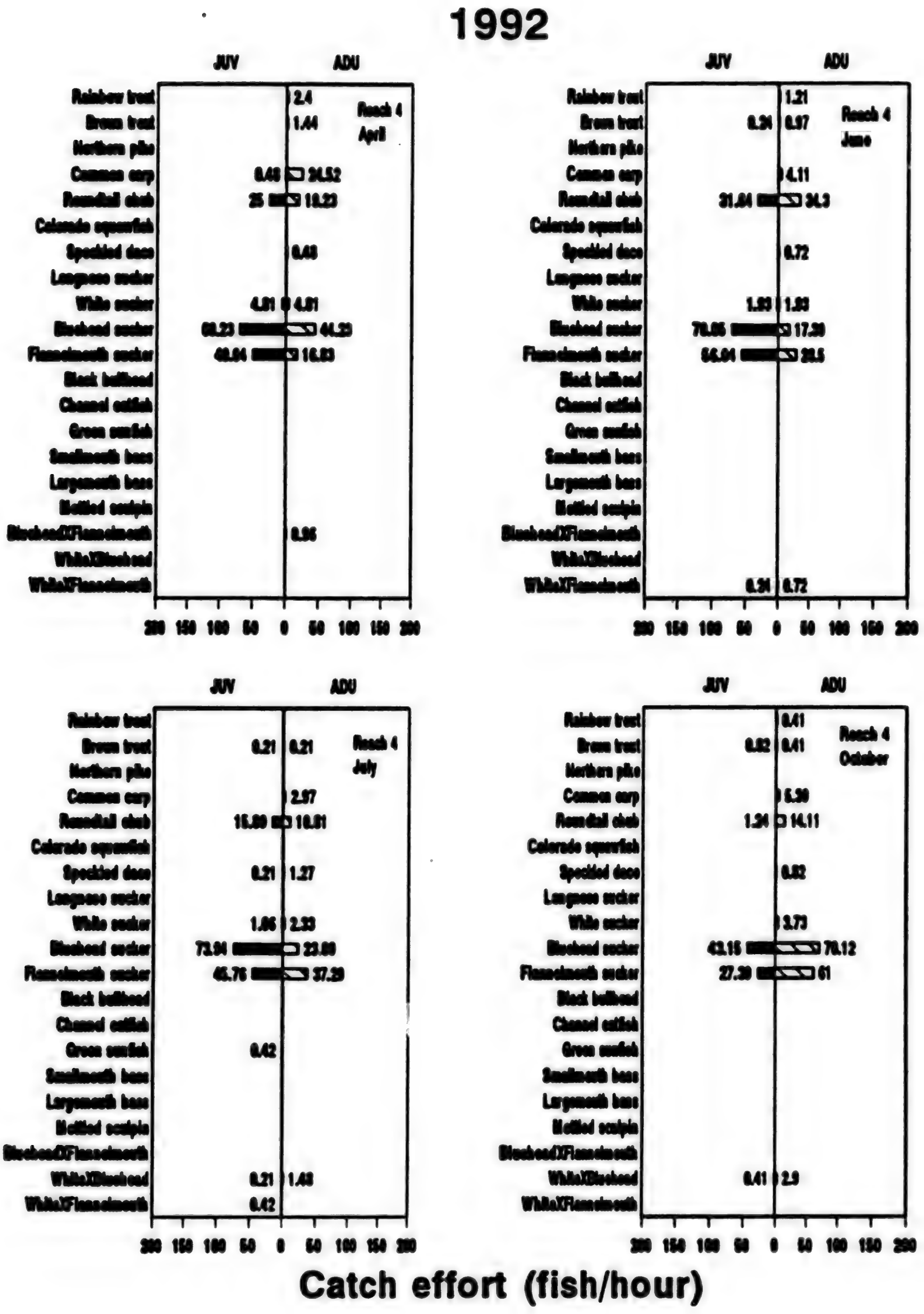

Figure H.4. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 4 of the Gunnison River, Colorado during April, June, July, and October 1992.

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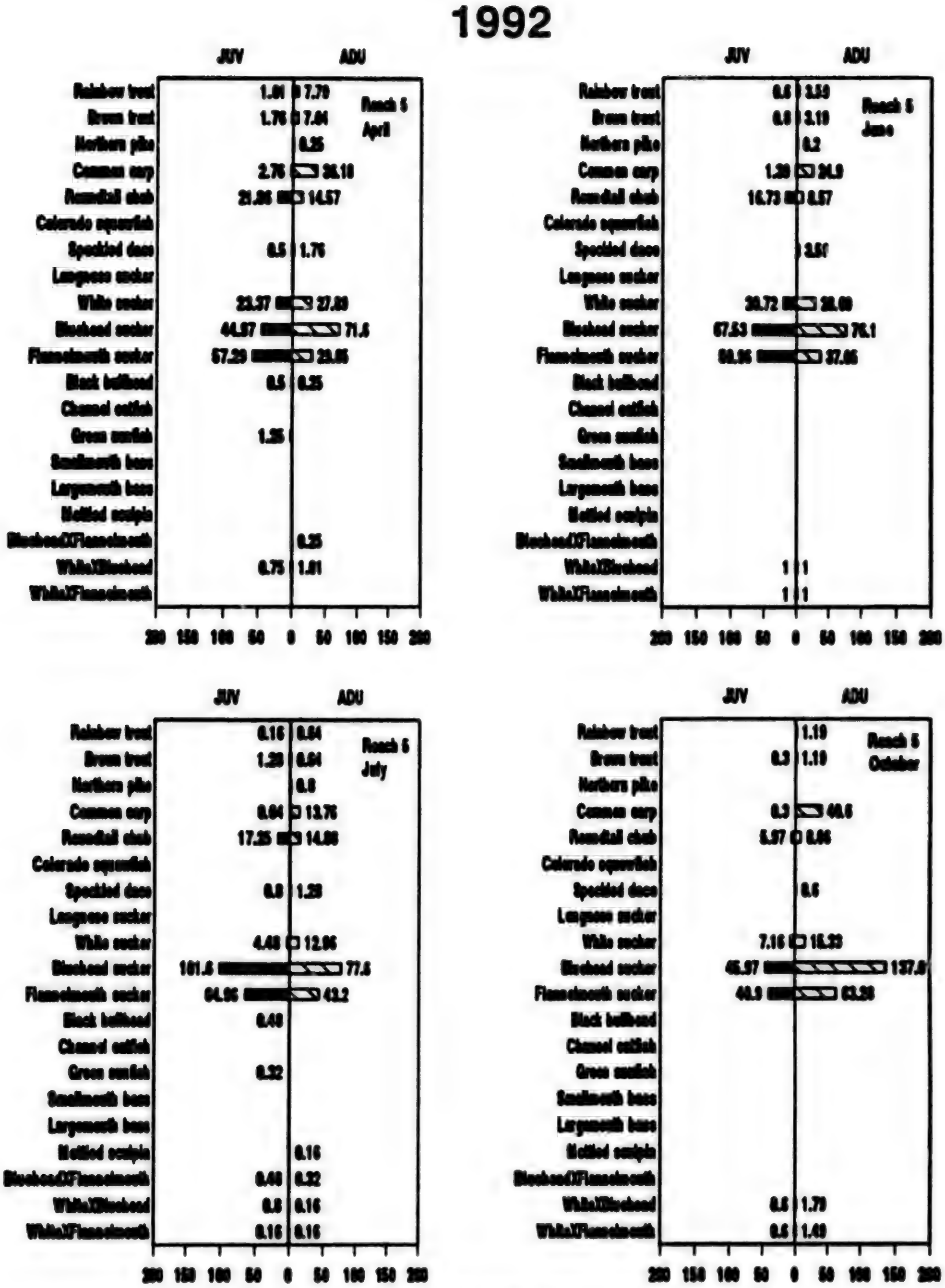

Figure H.5. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 5 of the Gunnison River, Colorado during April, June, July, and October 1992.

9 5

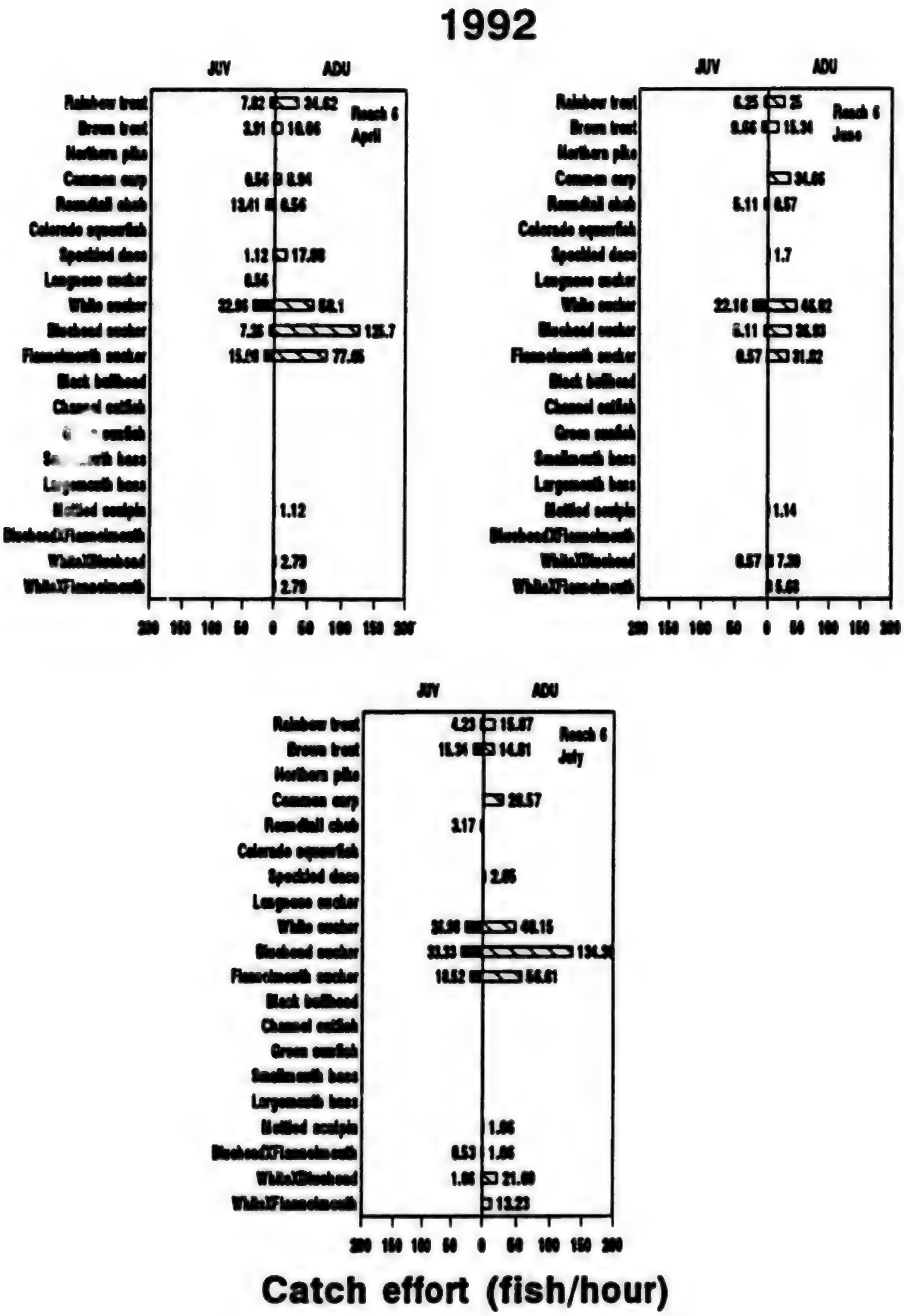

Figure H.6. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 6 of the Gunnison River, Colorado during April, June, and July 1992.

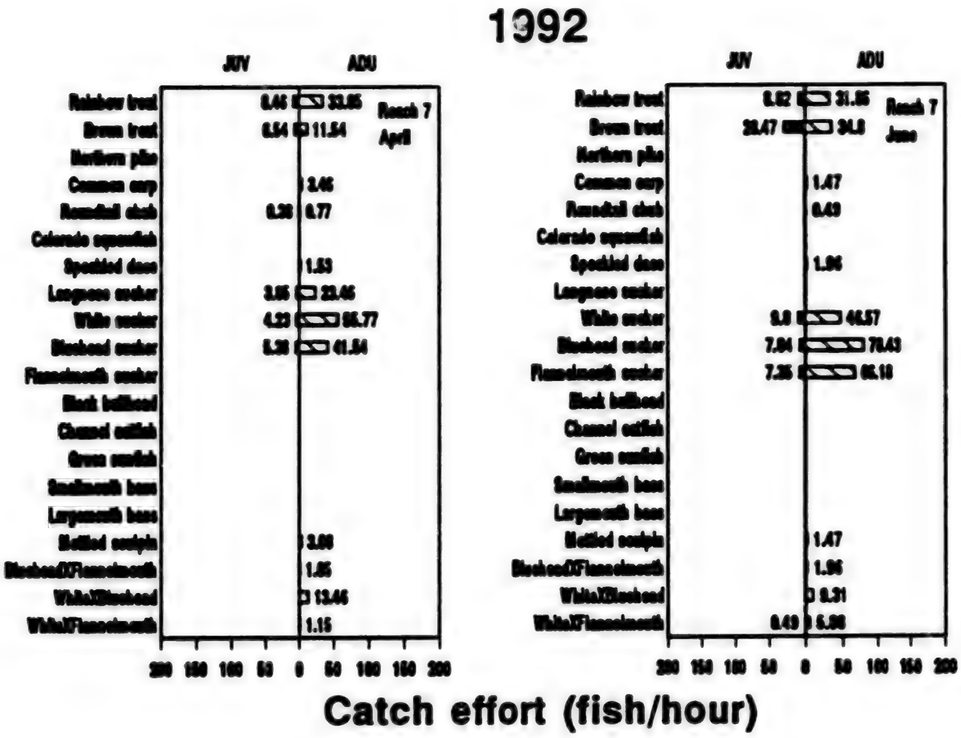

Figure H.7. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 7 of the Gunnison River, Colorado during April and June 1992.

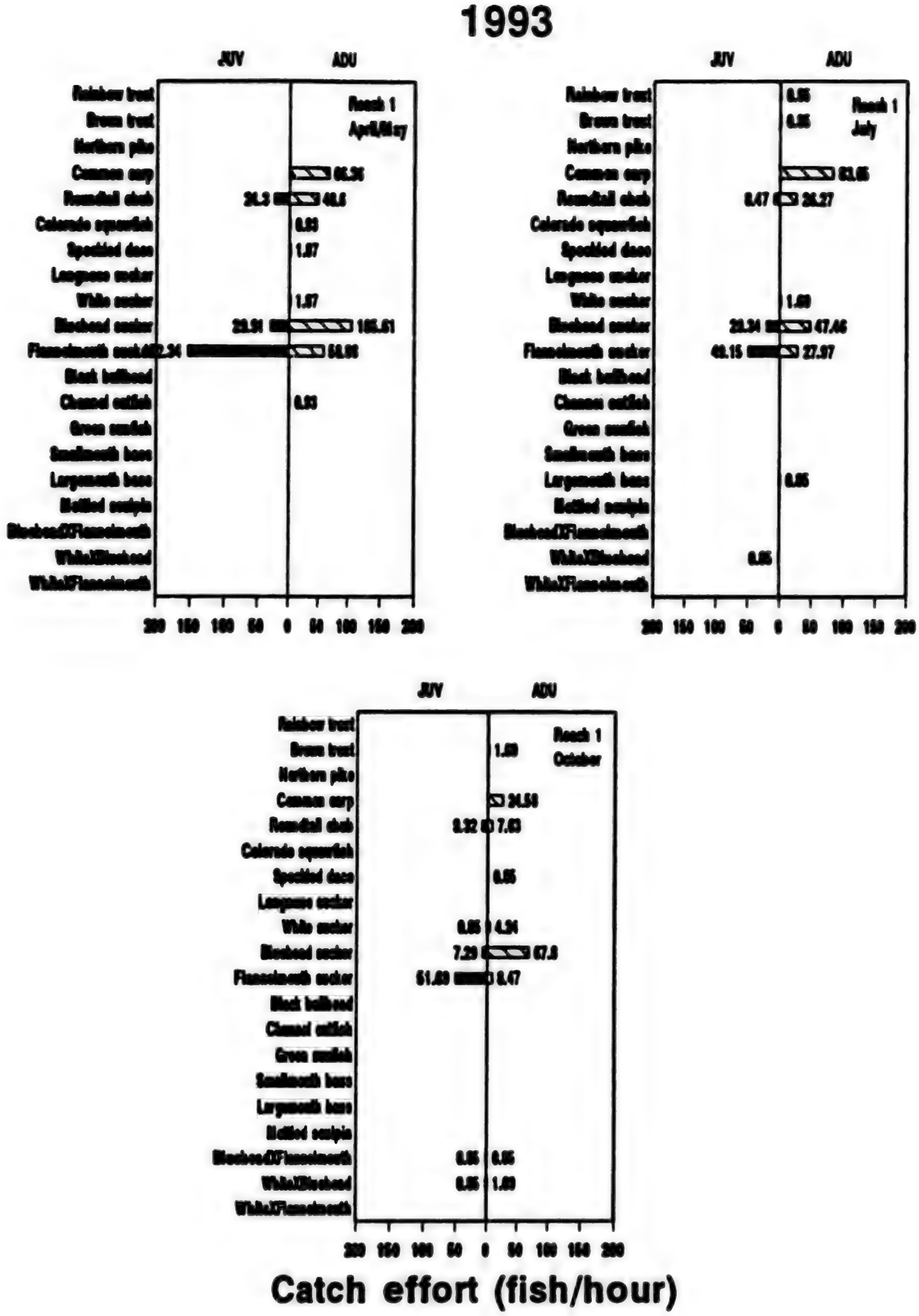

Figure H.8. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 1 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

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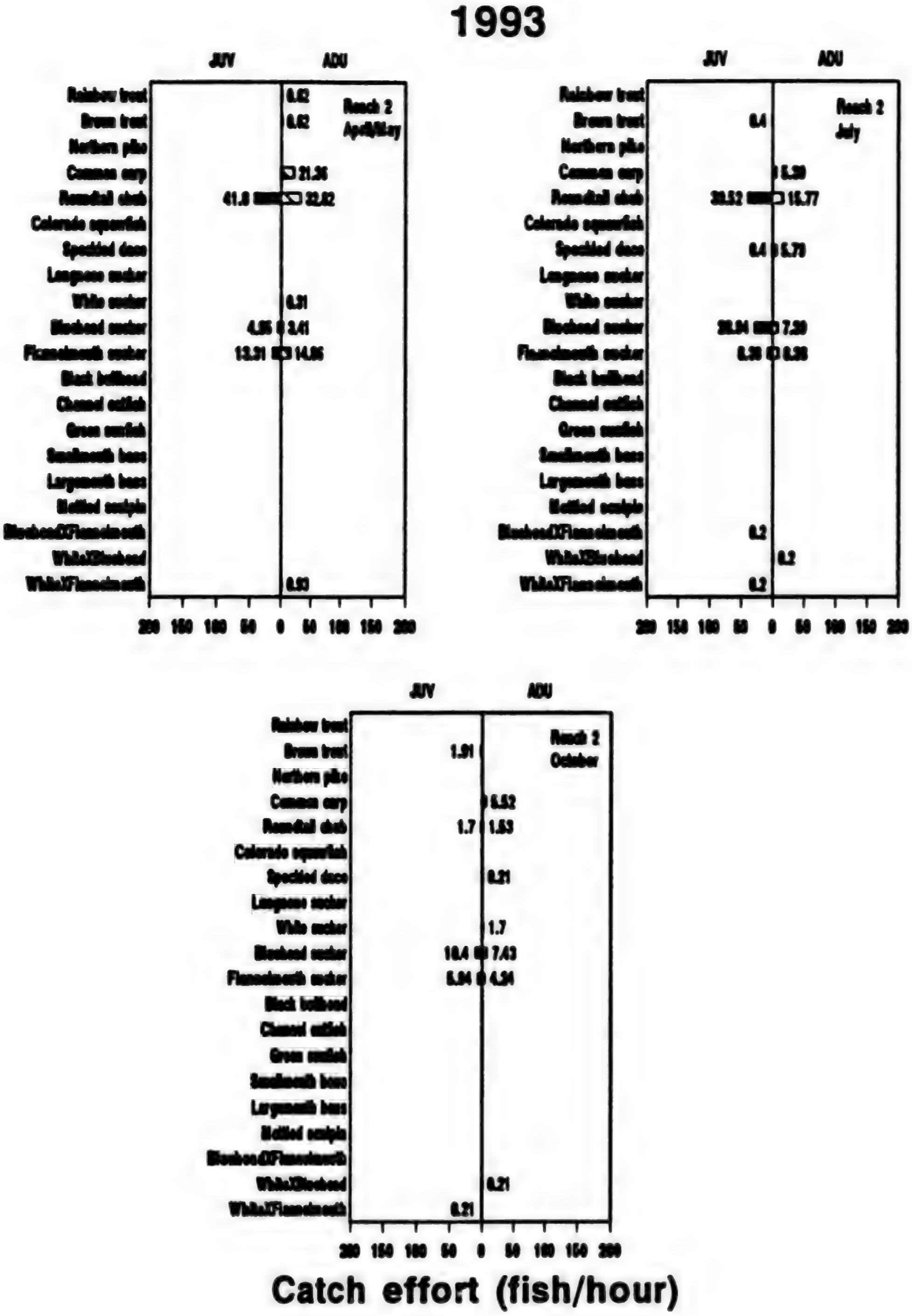

Figure H.9. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 2 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

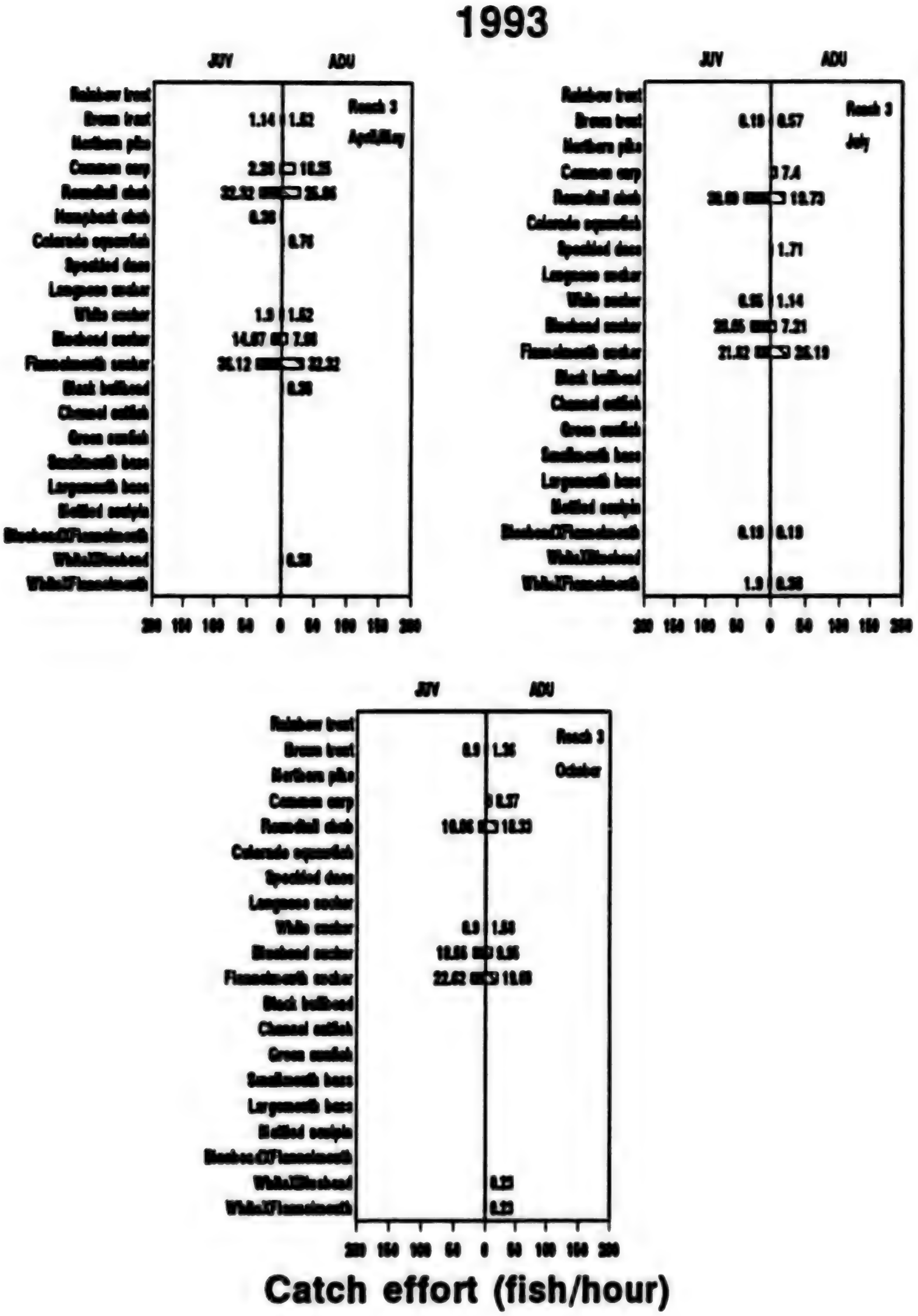

Figure H.10. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 3 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

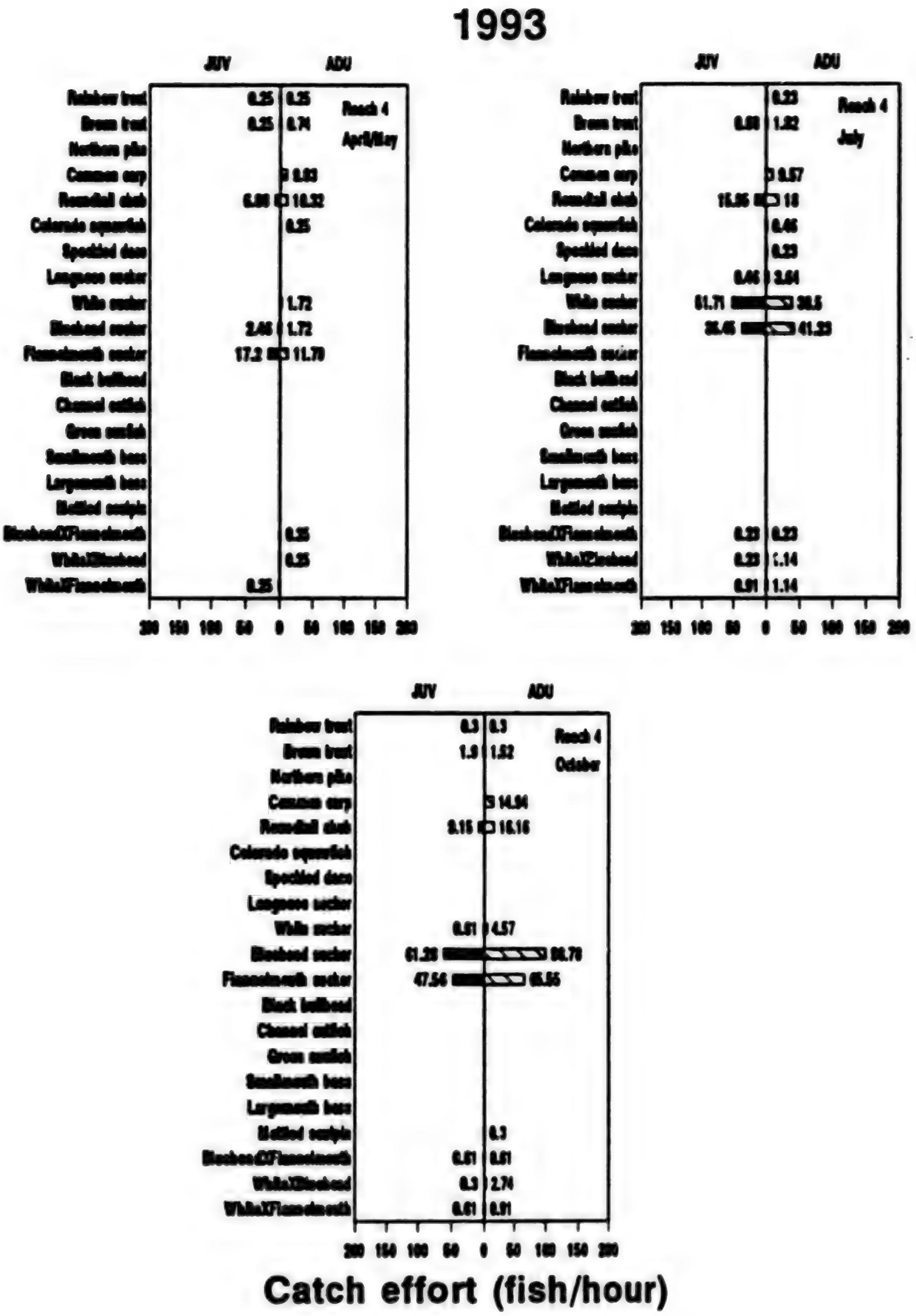

Figure H.11. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 4 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

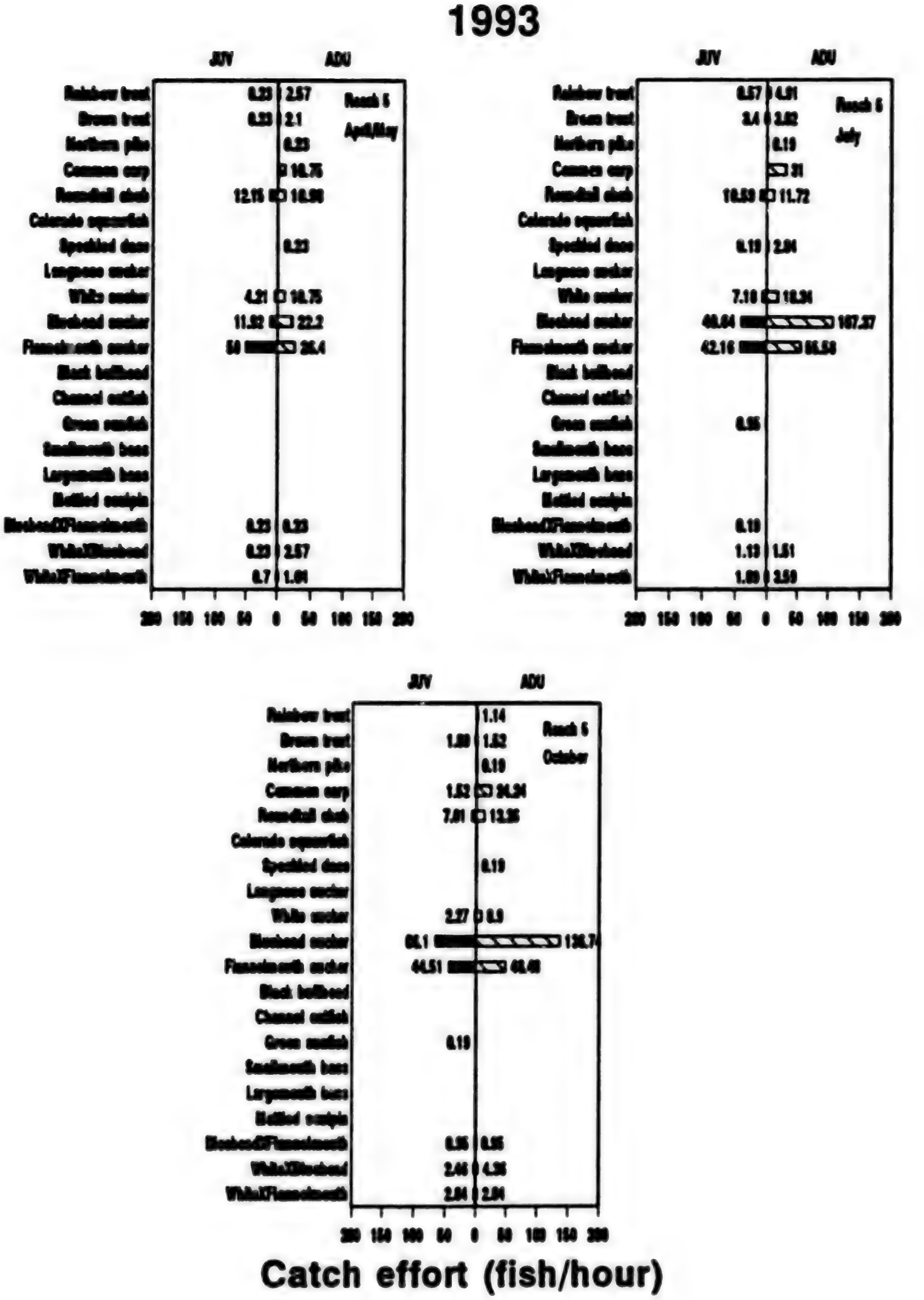

Figure H.12. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 5 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

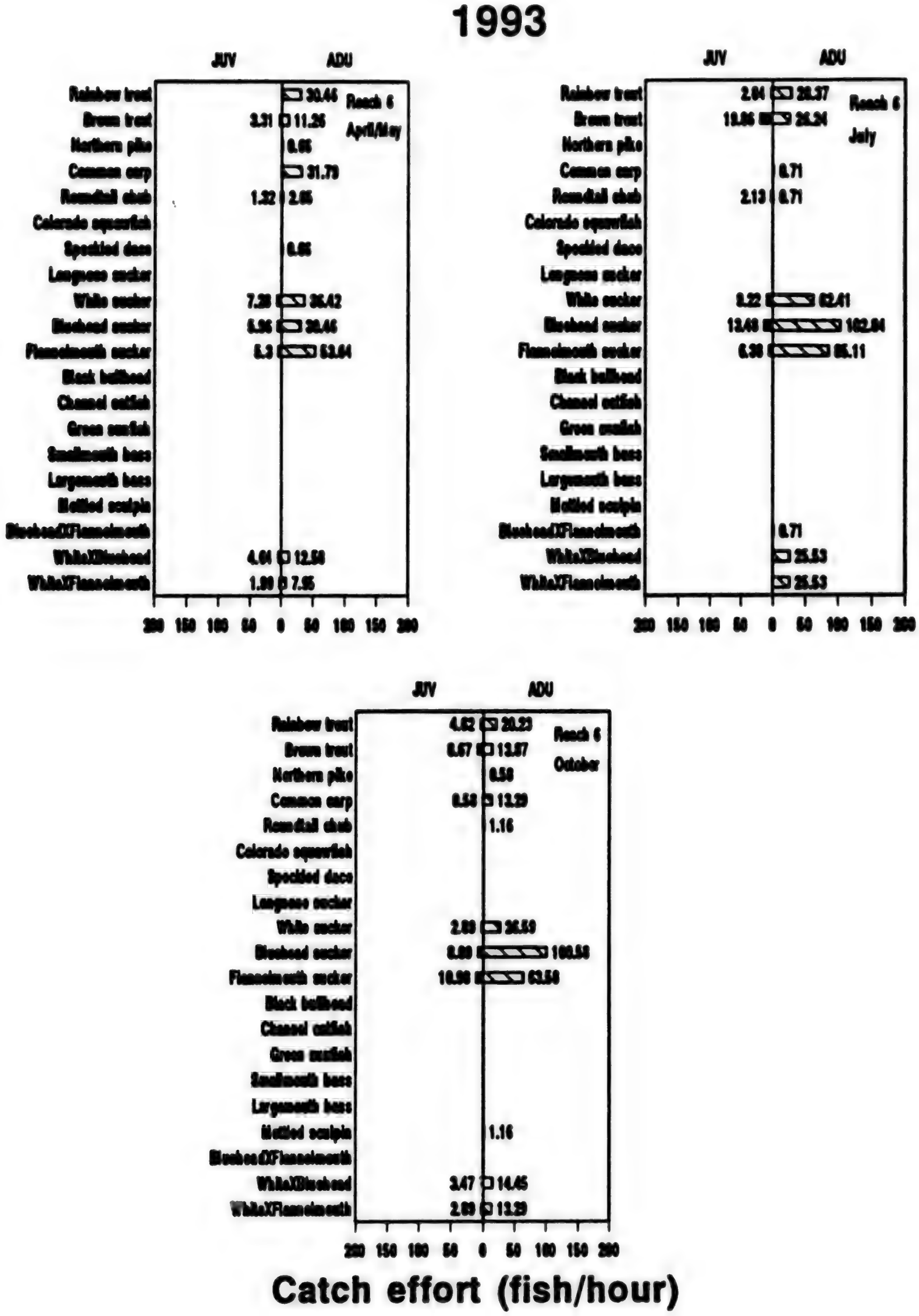

Figure H.13. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 6 of the Gunnison River, Colorado during April/May, June/July, and September/October 1993.

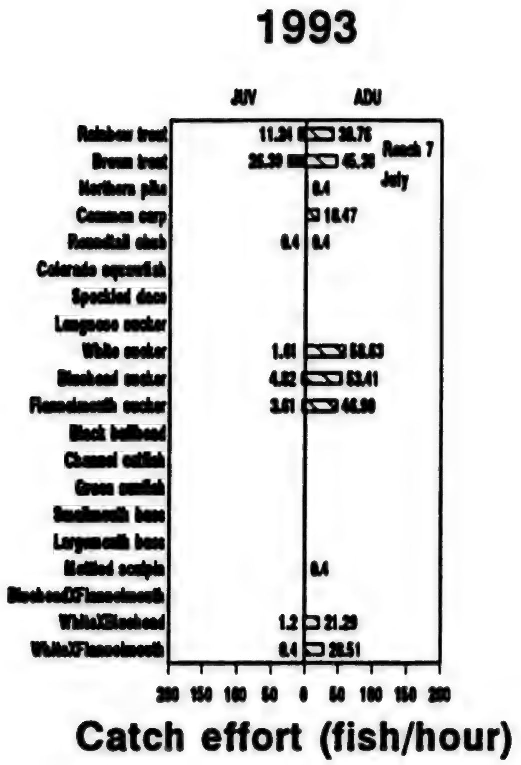

Figure H.14. Catch effort (total number of fish divided by total effort [hour]) for juvenile (JUV) and adult (ADU) fish collected by electrofishing in reach 7 of the Gunnison River, Colorado during July 1993.

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APPENDIX I

Total Length and Weight Statistics for Fishes Collected with Electrofishing During 1992 and 1993

Table I.1. Total length (TL[mm]) and weight (Wt[g]) statistics for bluehead sucker collected by electrofishing from seven reaches[a] of the Gunnison River, Colorado, April, June, July, and October 1992. See Figure 11.

	April							June						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	3	44	56	80	238	69	24	41	87	52	112	252	31	86
Mean	352	256	293	303	318	374	368	327	238	259	281	305	345	368
Min	317	120	195	190	65	225	180	217	106	129	141	69	98	143
Max	393	352	405	435	414	442	436	388	417	450	439	423	436	481
SD	31.4	50.8	46.5	52.3	53.1	37.3	54.2	41.6	60.1	70.9	62.1	69.6	68.5	51.0
Wt														
n	3	45	56	79	177	–	24	–	82	49	103	164	–	–
Mean	487	224	307	182	386	–	653	–	174	228	299	341	–	–
Min	340	80	110	70	45	–	60	–	25	50	50	36	–	–
Max	680	680	910	910	945	–	900	–	750	900	980	950	–	–
SD	142.7	132.6	169.7	182.7	199.5	–	218.7	–	132.5	189.9	200.5	187.9	–	–

	July							October						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	26	233	181	96	390	99	–	15	117	139	55	132	–	–
Mean	306	225	217	269	290	353	–	308	251	248	313	316	–	–
Min	200	74	83	133	83	193	–	187	114	73	239	161	–	–
Max	393	395	414	420	435	458	–	389	409	403	420	415	–	–
SD	44.8	71.6	75.9	74.0	66.7	43.6	–	51.5	66.4	69.7	48.9	51.1	–	–
Wt														
n	–	206	164	87	223	–	–	–	85	86	55	109	–	–
Mean	–	167	163	272	248	–	–	–	262	277	354	367	–	–
Min	–	3	6	35	10	–	–	–	85	20	140	90	–	–
Max	–	750	730	720	750	–	–	–	800	700	850	770	–	–
SD	–	129.7	160.6	180.3	163.3	–	–	–	159.9	146.3	163.5	161.1	–	–

---

[a] River reach 1: river mile 0.7-3.0
River reach 2: river mile 3.1-15.0
River reach 3: river mile 15.1-30.0
River reach 4: river mile 30.1-42.0
River reach 5: river mile 42.1-59.9
River reach 6: river mile 60.0-66.9
River reach 7: river mile 67.0-74.9

Table I.2. Total length (TL[mm]) and weight (Wt[g]) statistics for flannelmouth sucker collected by electrofishing from seven reaches[a] of the Gunnison River, Colorado, April, June, July, and October 1992. See Figure 12.

	April							June						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	18	35	61	76	187	67	14	119	142	134	152	204	43	80
Mean	437	366	333	351	368	459	468	350	358	367	388	378	440	465
Min	313	116	122	115	115	65	370	222	164	144	204	71	146	367
Max	512	488	550	522	535	558	539	533	558	545	533	542	540	538
SD	55.0	75.1	79.9	108.1	89.1	69.6	46.8	76.9	78.0	81.5	77.1	93.0	73.8	32.6
Wt														
n	18	35	60	74	82	–	14	–	141	132	151	130	–	–
Mean	941	562	470	611	635	–	1180	–	534	573	698	667	–	–
Min	270	20	75	20	15	–	318	–	40	30	75	35	–	–
Max	1650	1500	1800	1650	1500	–	1850	–	1850	1650	1650	1850	–	–
SD	360.1.	309.5	321.0	439.5	465.4	–	409.9	–	355.6	355.3	372.1	375.6	–	–

	July							October						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	73	147	207	144	210	32	–	23	25	116	44	78	–	–
Mean	320	356	345	366	359	421	–	357	336	354	403	400	–	–
Min	170	90	16	78	87	95	–	259	92	57	233	195	–	–
Max	508	524	540	531	557	540	–	470	520	535	492	532	–	–
SD	61.5	106.7	111.5	113.5	106.7	116.8	–	61.7	116.4	135.2	68.5	72.7	–	–
Wt														
n	–	144	201	128	143	–	–	–	21	104	43	67	–	–
Mean	–	606	563	678	585	–	–	–	608	660	666	644	–	–
Min	–	6	7	75	10	–	–	–	90	2	120	80	–	–
Max	–	1675	1825	1450	1300	–	–	–	1350	1550	1500	1600	–	–
SD	–	420.4	415.6	343.7	350.9	–	–	–	388.8	408.4	338.8	348.8	–	–

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[a] River reach 1: river mile 0.7-3.0
River reach 2: river mile 3.1-15.0
River reach 3: river mile 15.1-30.0
River reach 4: river mile 30.1-42.0
River reach 5: river mile 42.1-59.9
River reach 6: river mile 60.0-66.9
River reach 7: river mile 67.0-74.9

Table I.3. Total length (TL[mm]) and weight (Wt[g]) statistics for roundtail chub collected by electrofishing from seven reaches[a] of the Gunnison River, Colorado, April, June, July, and October 1992. See Figure 13.

	April							June						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	3	88	48	21	69	8	3	22	237	133	123	51	7	1
Mean	290	232	250	292	258	93	373	283	225	253	299	235	98	304
Min	213	89	99	174	58	69	186	164	103	91	99	85	70	–
Max	331	438	477	485	420	148	482	388	422	430	468	439	166	–
SD	54.3	89.1	94.8	84.0	89.1	31.3	132.8	56.6	74.0	95.0	93.6	90.1	31.2	–
Wt														
n	3	70	45	21	35	–	3	–	186	122	101	28	–	–
Mean	290	184	212	298	170	–	820	–	158	214	395	219	–	–
Min	230	15	20	50	10	–	60	–	15	15	60	30	–	–
Max	340	760	680	110	715	–	1300	–	660	670	1000	690	–	–
SD	45.5	165.0	192.0	263.2	186.3	–	543.6	–	143.3	187.8	228.5	186.3	–	–

	July							October						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	9	127	122	41	78	3	–	27	24	33	29	16	–	–
Mean	286	247	265	287	266	148	–	274	283	273	365	265	–	–
Min	238	111	73	135	98	110	–	145	145	138	127	92	–	–
Max	325	440	429	423	428	193	–	353	423	426	437	427	–	–
SD	9.8	78.8	86.6	89.4	81.1	34.3	–	47.0	96.0	85.1	56.4	85.4	–	–
Wt														
n	–	112	94	35	40	–	–	–	16	22	28	10	–	–
Mean	–	178	244	293	222	–	–	–	337	313	444	222	–	–
Min	–	14	14	50	25	–	–	–	80	26	240	70	–	–
Max	–	720	670	650	570	–	–	–	640	690	680	610	–	–
SD	–	148.7	155.9	199.9	151.7	–	–	–	165.4	191.0	118.3	149.7	–	–

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[a] River reach 1: river mile 0.7-3.0
River reach 2: river mile 3.1-15.0
River reach 3: river mile 15.1-30.0
River reach 4: river mile 30.1-42.0
River reach 5: river mile 42.1-59.9
River reach 6: river mile 60.0-66.9
River reach 7: river mile 67.0-74.9

Table I.4. Total length (TL[mm]) and weight (Wt[g]) statistics for bluehead sucker collected by electrofishing from seven reaches[a] of the Gunnison River, Colorado, April/May, June/July, and September/October 1993. See Figure 11.

	April/May							June/July						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	63	22	38	14	92	23	–	64	119	78	192	351	25	47
Mean	326	279	287	297	326	375	–	325	239	234	288	328	362	378
Min	242	105	145	215	192	318	–	252	64	72	108	130	303	300
Max	416	385	398	371	422	445	–	408	417	426	423	430	405	429
SD	39.5	55.2	54.7	51.1	48.4	38.7	–	38.6	82.4	84.8	68.6	51.7	25.5	31.7
Wt														
n	29	21	32	14	64	6	–	–	83	42	164	264	–	–
Mean	345	270	325	319	414	554	–	–	273	348	336	396	–	–
Min	140	100	140	120	150	305	–	–	90	100	75	31	–	–
Max	620	535	830	590	905	870	–	–	780	770	790	900	–	–
SD	111.2	116.3	171.9	152.1	190.9	181.4	–	–	141.7	216.2	174.0	149.8	–	–

	September/October						
Reach	1	2	3	4	5	6	7
TL							
n	78	83	53	184	365	48	–
Mean	291	285	282	307	323	373	–
Min	121	125	140	128	127	305	–
Max	442	398	390	428	435	461	–
SD	67.3	53.6	57.8	60.1	51.6	32.7	–
Wt							
n	–	77	48	182	292	–	–
Mean	–	297	294	403	400	–	–
Min	–	100	115	110	110	–	–
Max	–	650	590	980	1025	–	–
SD	–	117.2	131.6	185.6	164.7	–	–

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[a] River reach 1: river mile 0.7-3.0
River reach 2: river mile 3.1-15.0
River reach 3: river mile 15.1-30.0
River reach 4: river mile 30.1-42.0
River reach 5: river mile 42.1-59.9
River reach 6: river mile 60.0-66.9
River reach 7: river mile 67.0-74.9

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Table I.6. Total length (TL[mm]) and weight (Wt[g]) statistics for roundtail chub collected by electrofishing from seven reaches[a] of the Gunnison River, Colorado, April/May, June/July, and September/October 1993. See Figure 13.

	April/May							June/July						
Reach	1	2	3	4	5	6	7	1	2	3	4	5	6	7
TL														
n	53	151	125	45	58	6	–	30	179	252	108	83	4	1
Mean	286	278	278	296	277	320	–	294	229	231	279	293	212	298
Min	135	130	130	115	81	244	–	191	56	55	121	191	142	–
Max	388	460	447	467	475	420	–	396	428	437	448	477	315	–
SD	50.7	91.9	83.8	88.1	93.9	70.9	–	50.4	85.2	87.9	83.6	73.1	68.3	–
Wt														
n	4	102	93	37	36	2	–	–	117	132	86	51	–	–
Mean	368	364	325	363	348	455	–	–	207	252	291	324	–	–
Min	290	70	80	90	75	130	–	–	60	70	70	85	–	–
Max	410	840	850	915	1300	780	–	–	700	655	1000	1450	–	–
SD	47.2	207.0	199.0	230.0	298.7	325.0	–	–	141.8	162.5	197.0	246.3	–	–

	September/October						
Reach	1	2	3	4	5	6	7
TL							
n	18	100	96	51	92	3	–
Mean	256	310	298	312	300	340	–
Min	191	82	82	163	143	290	–
Max	386	438	445	443	475	366	–
SD	48.2	89.5	79.6	78.1	68.0	35.1	–
Wt							
n	–	90	83	41	80	–	–
Mean	–	344	285	364	291	–	–
Min	–	80	65	110	80	–	–
Max	–	740	800	800	880	–	–
SD	–	181.3	176.8	168.0	168.8	–	–

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[a] River reach 1: river mile 0.7-3.0
River reach 2: river mile 3.1-15.0
River reach 3: river mile 15.1-30.0
River reach 4: river mile 30.1-42.0
River reach 5: river mile 42.1-59.9
River reach 6: river mile 60.0-66.9
River reach 7: river mile 67.0-74.9

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Table I.7. Total length (TL[mm]) and weight (Wt[g]) statistics for rainbow trout and brown trout collected by electrofishing from Reaches 1-5 (river mile 0.7-59.5) and Reaches 6-7 (river mile 60.0-74.9) of the Gunnison River, Colorado, 1992 and 1993. Note: In 1992, April, June, and July, and October collections were pooled; in 1993 April/May, June/July, and September/October collections were pooled.

	Stream Reaches			
	1-5		6-7	
Year	1992	1993	1992	1993
Common Name				
Rainbow trout				
TL				
n	58	48	211	190
Mean	315	336	332	333
Min	167	159	127	155
Max	512	535	470	492
SD	60.4	64.1	71.4	58.0
Wt				
n	29	15	38	9
Mean	311	310	438	427
Min	64	195	45	210
Max	1000	500	950	670
SD	170.8	83.3	256.1	122.9
Brown trout				
TL				
n	96	103	201	404
Mean	305	275	287	282
Min	140	33	43	145
Max	496	520	505	451
SD	72.9	80.6	83.1	65.9
Wt				
n	43	27	9	2
Mean	409	478	556	570
Min	75	135	25	570
Max	1250	2000	1350	570
SD	279.1	448.1	388.9	0.0

Table I.8. Total length (TL[mm]) and weight (Wt [g]) statistics for white sucker and carp collected by electrofishing from seven reaches of the Gunnison River, Colorado, 1992. Note: April, June, July, and October collections were pooled. See Figure 14.

	River Reach[a]						
Common Name	1	2	3	4	5	6	7
White sucker							
TL							
n	15	15	26	19	278	188	103
Mean	350	354	348	340	322	330	375
Min	222	270	178	258	69	53	150
Max	418	420	481	427	485	503	479
SD	48.2	49.8	70.5	50.6	59.8	75.9	70.5
Wt							
n	1	14	26	19	84	--	14
Mean	1150	538	514	488	350	--	724
Min	--	190	56	180	80	--	110
Max	--	880	1075	925	980	--	1200
SD	--	221.1	276.8	220.4	188.6	--	249.5
Carp							
TL							
n	18	17	18	14	52	12	4
Mean	428	486	508	462	422	489	592
Min	233	189	320	319	87	343	550
Max	582	669	632	585	687	658	640
SD	102.4	132.5	104.6	104.6	153.8	106.0	40.4
Wt							
n	2	12	17	13	38	--	1
Mean	750	2385	2639	1864	1613	--	2450
Min	150	230	330	500	25	--	110
Max	1350	4450	4750	3350	3500	--	--
SD	600.0	1494	1409	1088	1115	--	--

[a] River Reach 1: River mile 0.7-3.0
River Reach 2: River mile 3.1-15.0
River Reach 3: River mile 15.1-30.0
River Reach 4: River mile 30.1-42.0
River Reach 5: River mile 42.1-59.9
River Reach 6: River mile 60.0-66.9
River Reach 7: River mile 67.0-74.9

Table I.9. Total length (TL[mm]) and weight (Wt [g]) statistics for white sucker and carp collected by electrofishing from seven reaches of the Gunnison River, Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled. See Figure 14.

	River Reach[a]						
Common Name	1	2	3	4	5	6	7
White sucker							
TL							
n	9	9	20	23	206	150	82
Mean	334	377	324	355	334	361	382
Min	172	320	158	214	75	78	167
Max	420	428	454	486	465	463	470
SD	69.0	34.0	96.8	55.3	52.4	54.0	46.6
Wt							
n	--	8	17	23	69	5	--
Mean	--	696	561	552	508	864	--
Min	--	420	120	100	130	600	--
Max	--	1170	1100	1375	1275	1250	--
SD	--	237.2	311.8	255.2	239.9	213.1	--
Carp							
TL							
n	21	--	3	1	9	2	1
Mean	494	--	447	361	417	538	425
Min	375	--	360	--	270	517	--
Max	590	--	563	--	504	559	--
SD	56.3	--	85.3	--	90.3	21.0	--
Wt							
n	--	--	1	1	4	1	--
Mean	--	--	1250	800	1206	2550	--
Min	--	--	--	--	350	--	--
Max	--	--	--	--	1800	--	--
SD	--	--	--	--	541.5	--	--

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[a] River Reach 1: River mile 0.7-3.0
River Reach 2: River mile 3.1-15.0
River Reach 3: River mile 15.1-30.0
River Reach 4: River mile 30.1-42.0
River Reach 5: River mile 42.1-59.9
River Reach 6: River mile 60.0-66.9
River Reach 7: River mile 67.0-74.9

Table I.10. Total length (TL [mm]) and weight (Wt [g]) statistics for fishes collected by electrofishing from the Gunnison River (river mile 0.7-74.9), Colorado, 1992. Note: April, June, and July, and October collections were pooled.

		TL (mm)					Wt (g)			
Common Name	n	Mean	Min	Max	SD	n	Mean	Min	Max	SD
northern pike	9	683	545	915	107.8	1	5424	—	—	—
common carp	135	483	87	687	106.5	95	1950	25	3500	1141
Colorado squawfish	3	709	652	762	45.0	3	3507	2240	5230	1263.0
speckled dace	62	80	33	127	16.0	—	—	—	—	—
white sucker	644	347	322	503	60.8	158	627	56	880	231.3
black bullhead	4	190	136	255	49.7	—	—	—	—	—
channel catfish	13	404	243	644	107.9	1	3250	—	—	—
green sunfish	6	111	88	155	25.2	4	46	12	85	27.4
smallmouth bass	0	—	—	—	—	0	—	—	—	—
largemouth bass	0	—	—	—	—	0	—	—	—	—
mottled sculpin	13	96	77	121	11.7	—	—	—	—	—
Hybrids										
bluehead sucker x flannelmouth sucker	21	375	195	499	92.9	15	616	75	1425	438.6
white sucker x bluehead sucker	71	350	238	468	49.6	25	430	210	900	179.7
white sucker x flannelmouth sucker	47	427	266	522	65.8	21	812	240	1575	385.1

Table I.11. Total length (TL [mm]) and weight (Wt [g]) statistics for fishes collected by electrofishing from the Gunnison River (river mile 0.7-74.9), Colorado, 1993. Note: April/May, June/July, and September/October collections were pooled.

		TL (mm)					Wt (g)			
Common Name	n	Mean	Min	Max	SD	n	Mean	Min	Max	SD
northern pike	11	680	400	835	124.4	11	2514	590	4600	1176.4
common carp	37	468	270	590	77.8	7	1346	350	2550	655.5
humpback chub	1	255	—	—	—	1	165	—	—	—
Colorado squawfish	10	668	497	901	117.3	10	3101	1050	6560	1780.6
speckled dace	41	78	52	104	12.9	0	—	—	—	—
white sucker	499	351	75	486	57.8	122	551	100	1375	264.7
black bullhead	0	—	—	—	—	0	—	—	—	—
channel catfish	1	360	—	—	—	0	—	—	—	—
green sunfish	6	111	88	155	25.2	4	46	12	85	27.4
smallmouth bass	0	—	—	—	—	0	—	—	—	—
largemouth bass	0	—	—	—	—	0	—	—	—	—
mottled sculpin	3	104	79	133	22.2	0	—	—	—	—
Hybrids										
bluehead sucker x flannelmouth sucker	21	360	132	505	92.6	15	573	230	1350	298.8
white sucker x bluehead sucker	120	352	130	462	50.1	30	385	150	820	153.1
white sucker x flannelmouth sucker	155	407	85	530	74.1	46	586	110	1750	380.4

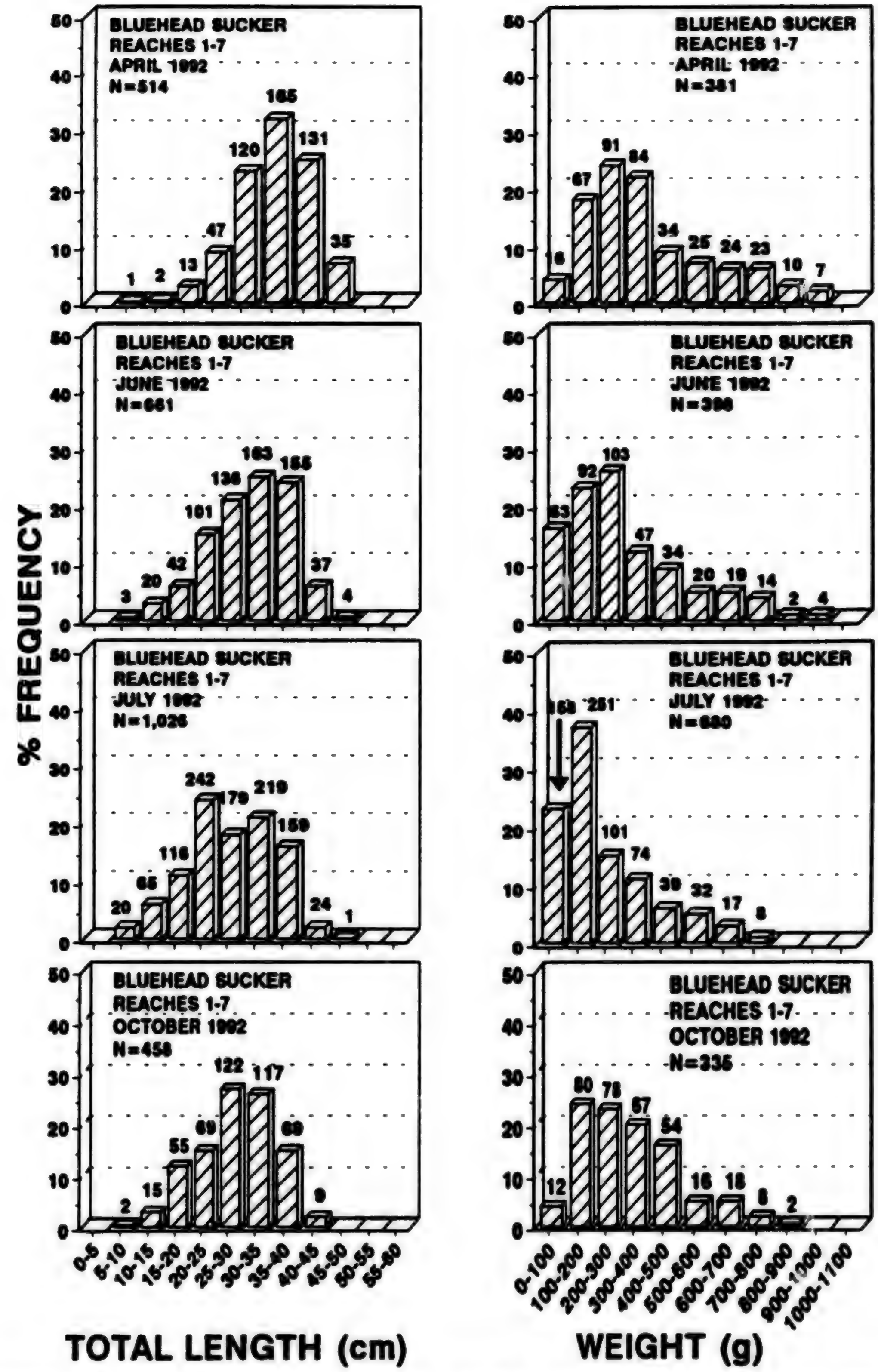

Figure I.1. Total length (cm) and weight (g) frequency composition for bluehead sucker collected by electrofishing from the Gunnison River, Colorado, during April, June, July, and October 1992. Reach data were pooled; numbers above bars represent sample size.

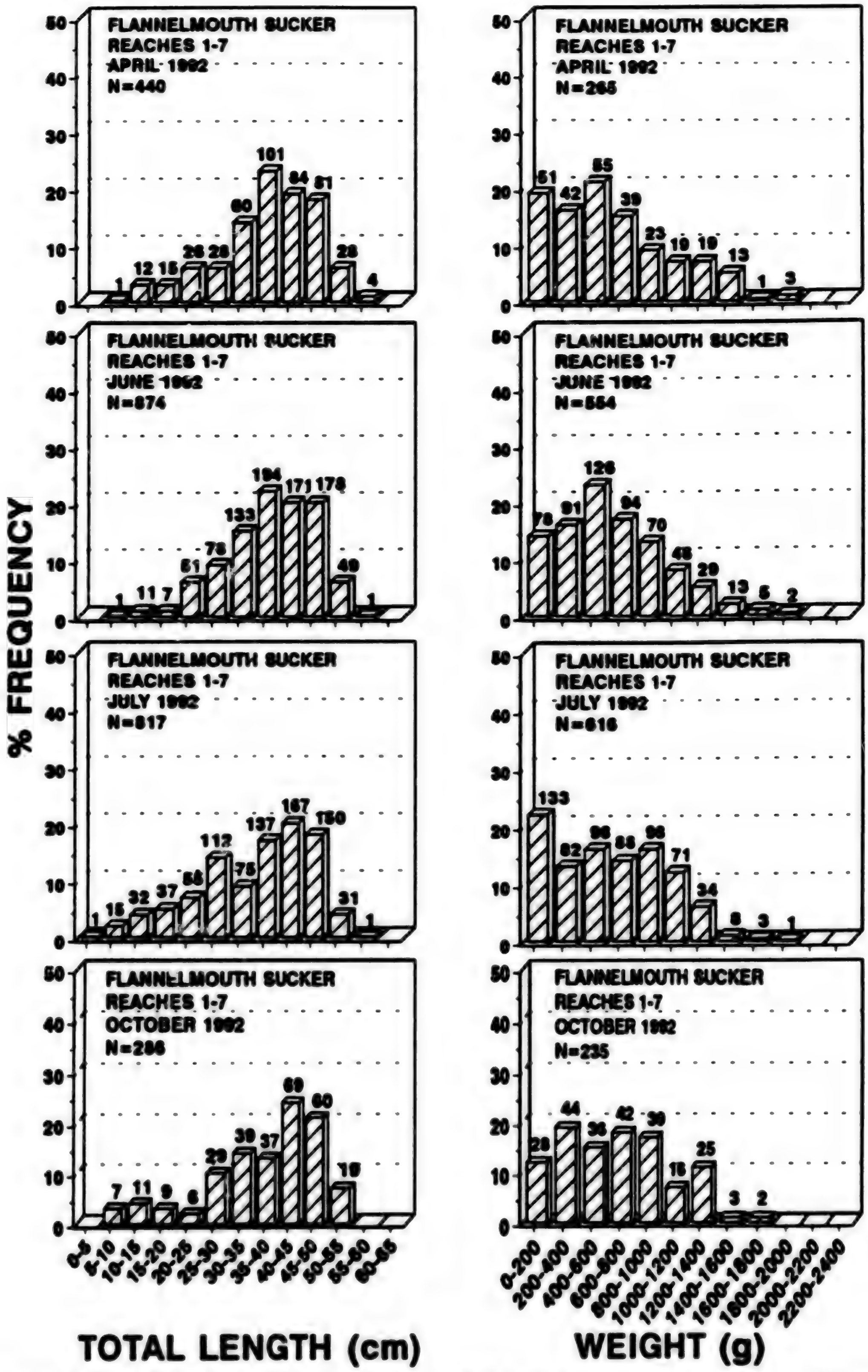

Figure I.2. Total length (cm) and weight (g) frequency composition for flannelmouth sucker collected by electrofishing from the Gunnison River, Colorado, during April, June, July, and October 1992. Reach data were pooled; numbers above bars represent sample size.

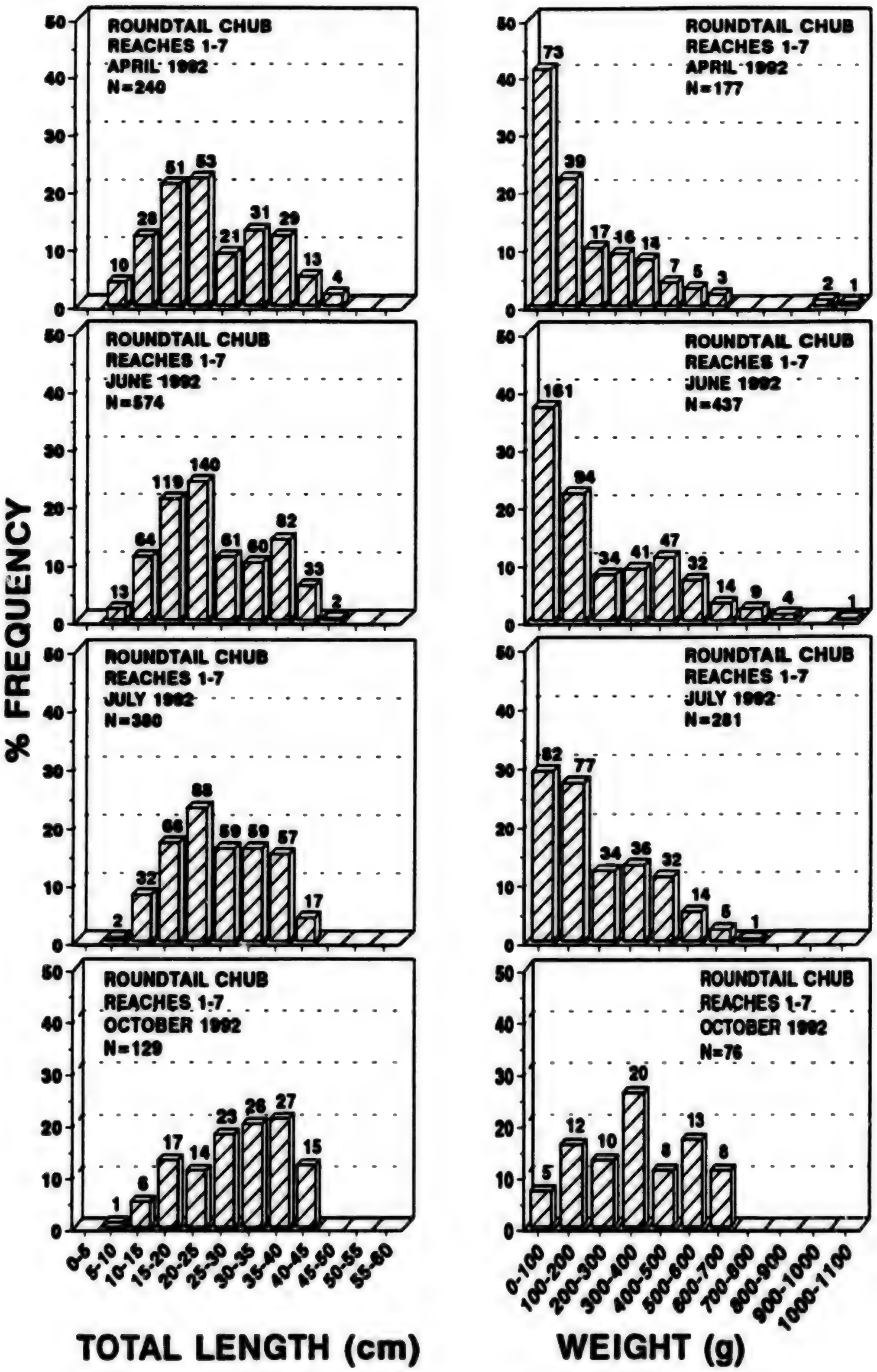

Figure I.3. Total length (cm) and weight (g) frequency composition for roundtail chub collected by electrofishing from the Gunnison River, Colorado, during April, June, July, and October 1992. Reach data were pooled; numbers above bars represent sample size.

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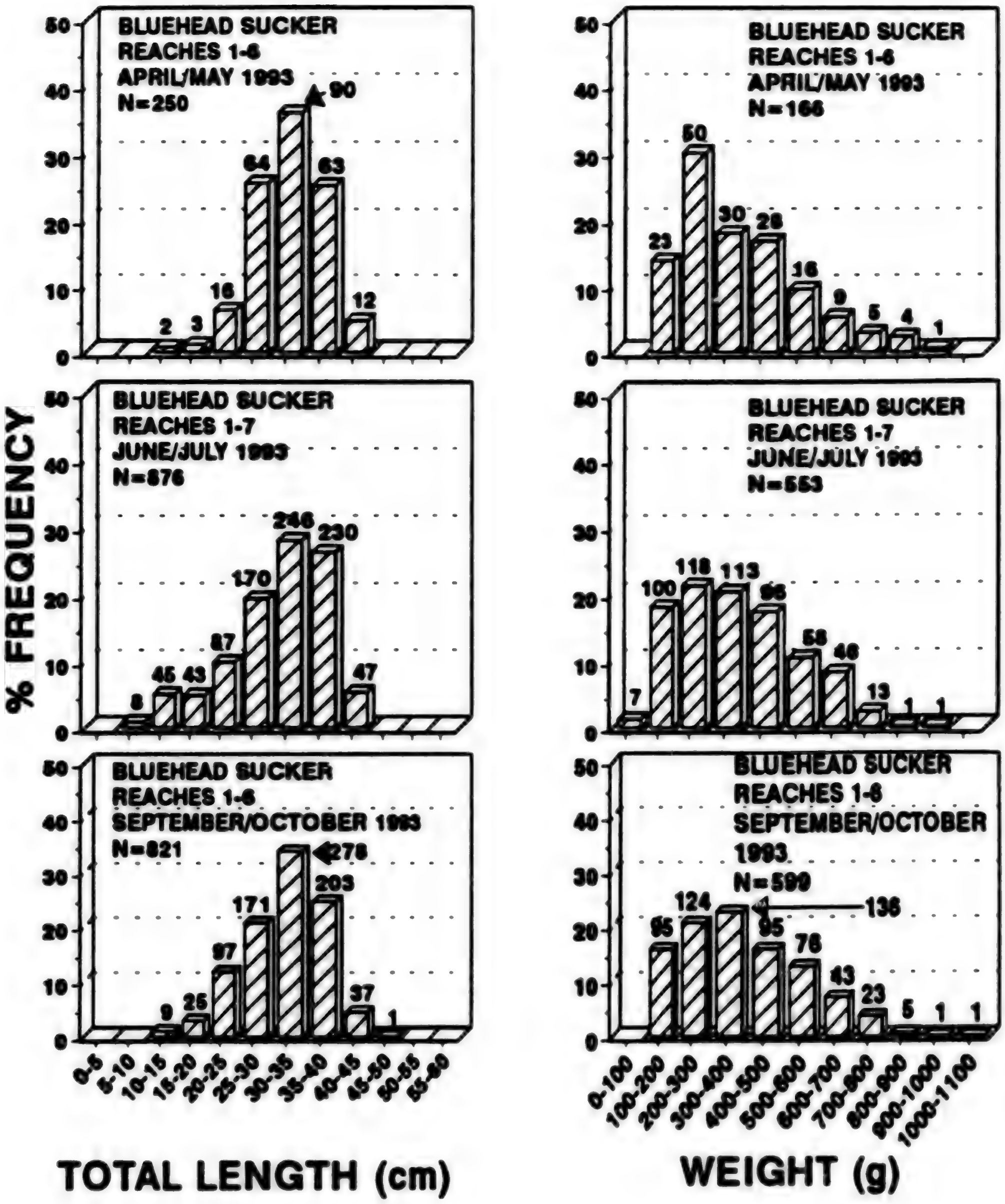

Figure I.4. Total length (cm) and weight (g) frequency composition for bluehead sucker collected by electrofishing from the Gunnison River, Colorado, during April/May, June/July, and September/October 1993. Reach data were pooled; numbers above bars represent sample size.

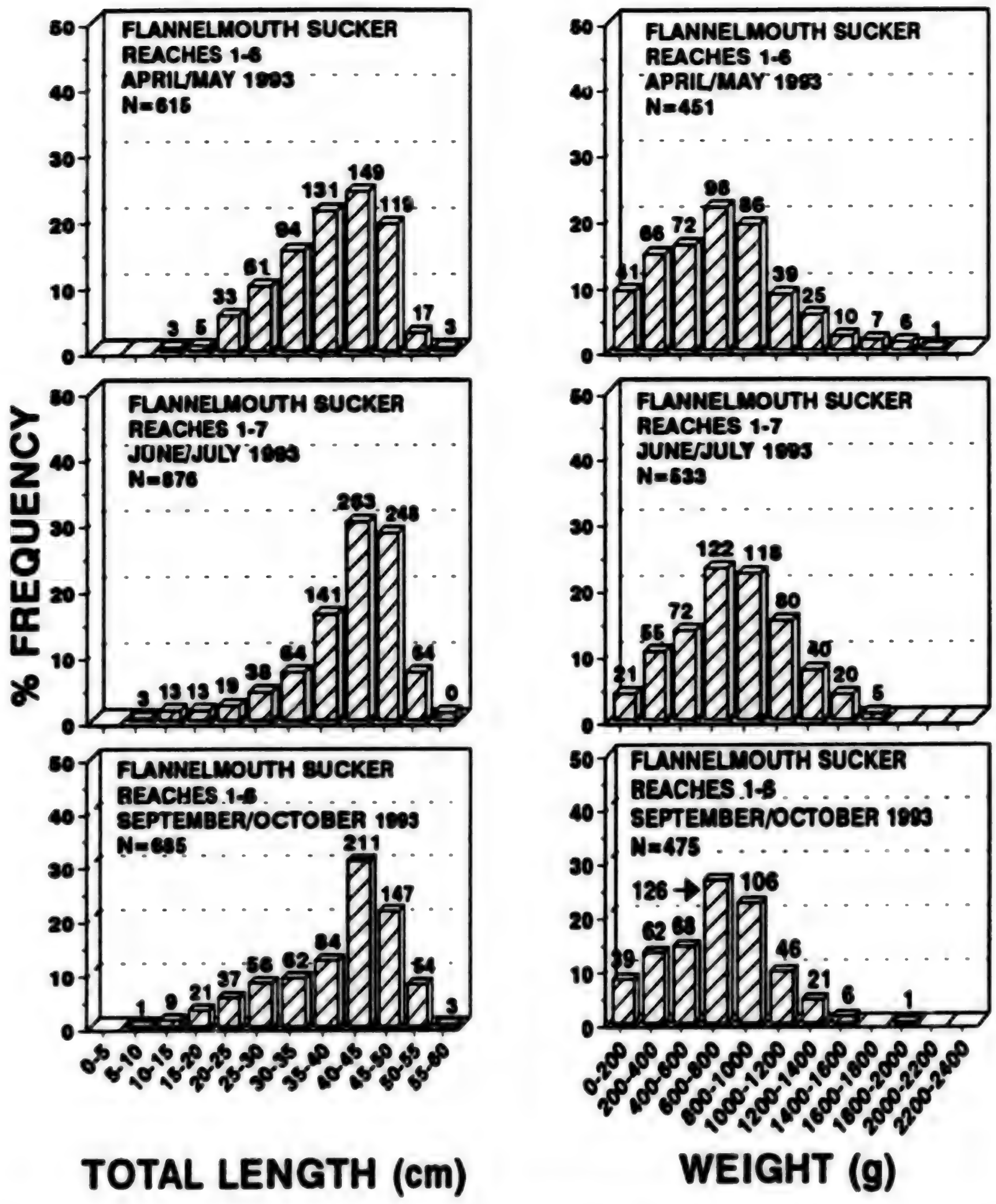

Figure I.5. Total length (cm) and weight (g) frequency composition for flannelmouth sucker collected by electrofishing from the Gunnison River, Colorado, during April/May, June/July, and September/October 1993. Reach data were pooled; numbers above bars represent sample size.

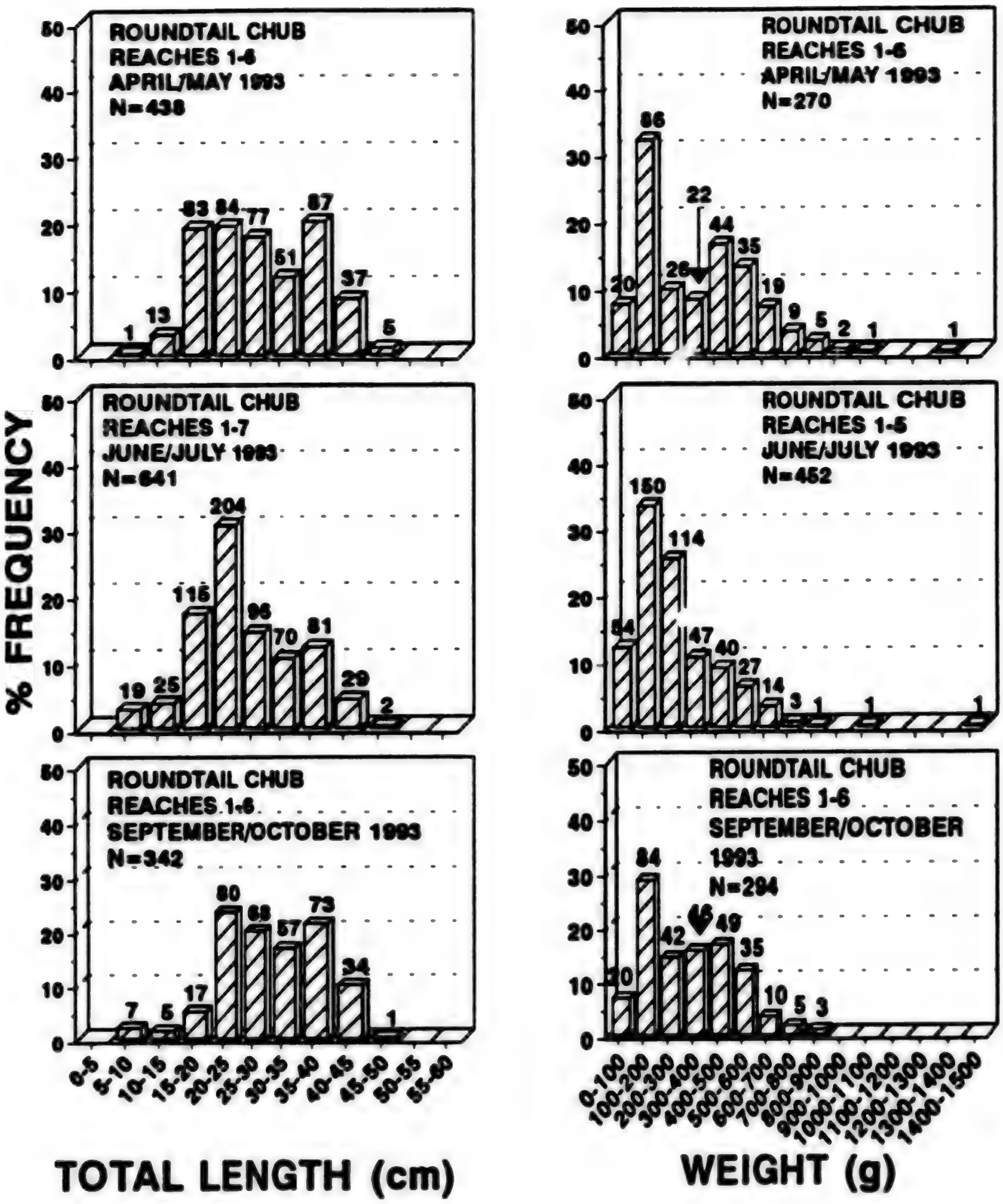

Figure I.6. Total length (cm) and weight (g) frequency composition for roundtail chub collected by electrofishing from the Gunnison River, Colorado, during April/May, June/July, and September/October 1993. Rreach data were pooled; number above bars represent sample size.

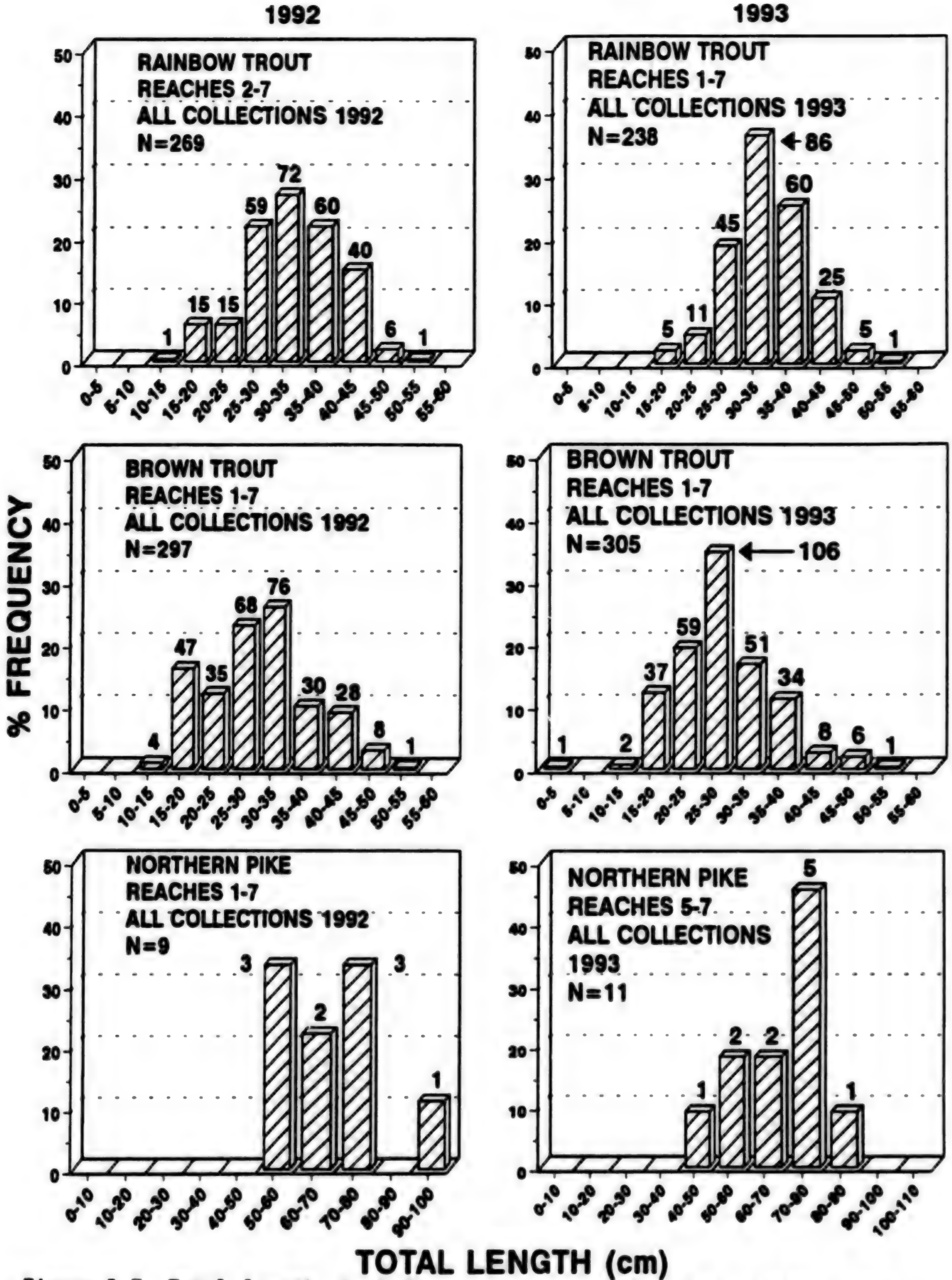

Figure I.7. Total length (cm) frequency composition for rainbow trout, brown trout, and northern pike collected by electrofishing from the Gunnison River, Colorado, 1992. Data for both reaches and sampling dates were pooled; numbers above bars represent sample size.

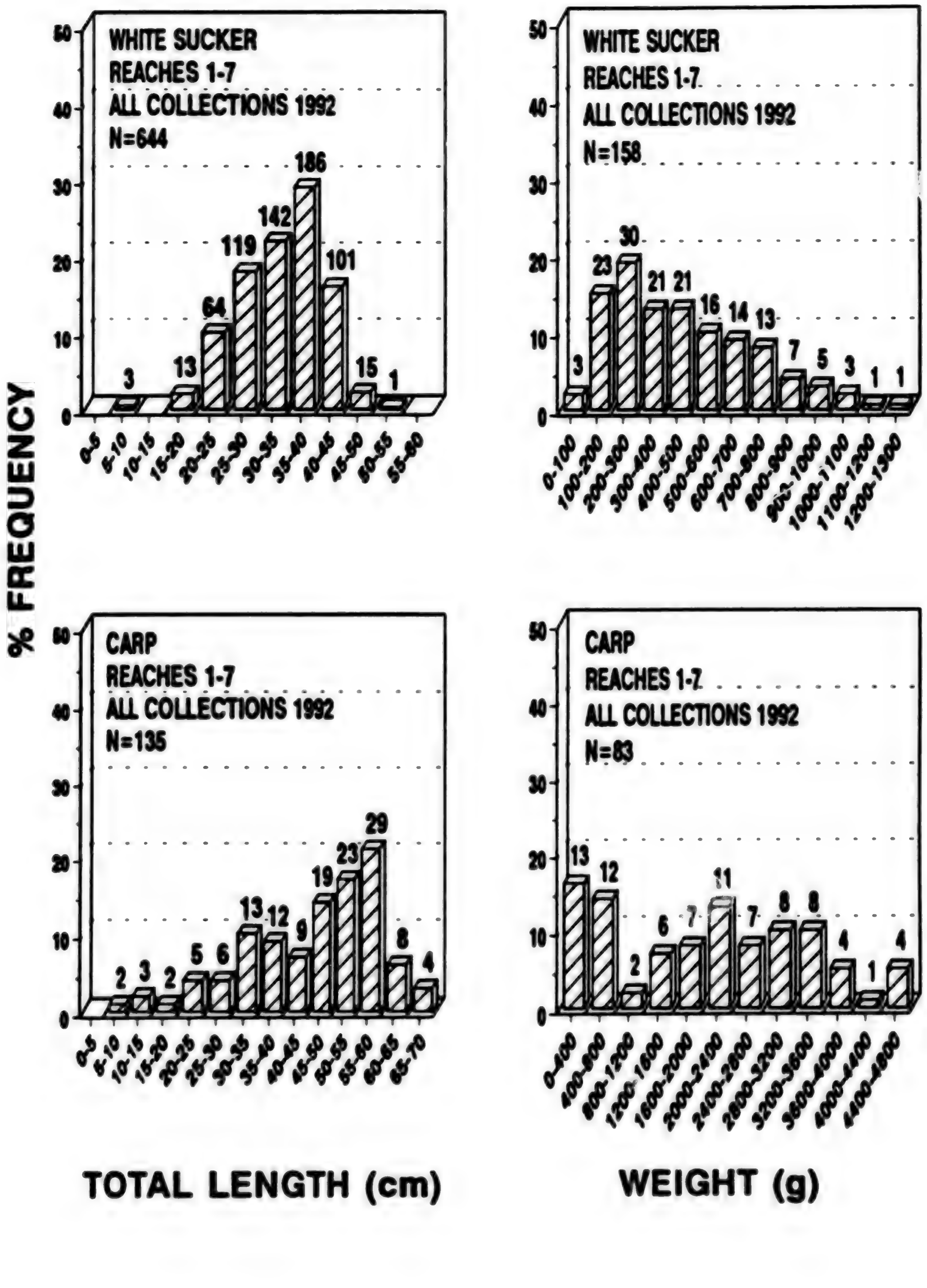

Figure I.8. Total length (cm) and weight (g) frequency composition for white sucker and common carp collected by electrofishing from the Gunnison River, Colorado, 1992. Data for both reaches and sampling dates were pooled; numbers above bars represent sample size.

APPENDIX J

Catch Statistics for Larval Fishes, 1992 and 1993

Table J.1. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reaches 2, 3, 4, and 5, Gunnison River, Colorado, between 3 and 7 August 1992.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	178	249	10	5	1	4	4	5	3	459	7.35
Common carp	0	0	0	2	2	0	0	0	0	0	4	0.06
Roundtail chub	0	1	2	24	90	147	101	15	2	0	382	6.12
Sand shiner	0	10	127	259	83	8	5	2	6	0	500	8.01
Fathead minnow	4	1,111	1,756	1,029	223	42	7	0	1	34	4,207	67.41
Speckled dace	0	1	23	64	59	22	9	2	1	0	186	2.98
Unidentified minnow	0	2	3	0	0	0	0	0	0	60	65	1.04
Bluehead sucker	0	0	35	128	120	63	21	8	2	0	377	6.04
Flannelmouth sucker	0	0	0	0	4	7	4	5	2	0	22	0.35
White sucker	0	0	0	6	3	7	4	1	0	0	21	0.34
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Plains killifish	0	0	0	5	6	3	2	0	2	0	18	0.29
Total	-	-	-	-	-	-	-	-	-	-	6,241	100.00

Number of samples: 35; % native fishes: 15.49; % non-native fishes: 84.51

Table J.2. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reaches 2, 3, 4, and 5, Gunnison River, Colorado between 3 and 6 August 1993.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	6	1	1	1	1	6	5	0	0	21	0.17
Common carp	0	18	8	0	0	0	0	0	0	0	26	0.21
Roundtail chub	0	18	671	712	968	294	16	0	0	76	2,755	22.07
Sand shiner	0	6	3	0	0	0	0	2	0	0	11	0.09
Fathead minnow	2	1,252	227	27	19	18	16	4	0	59	1,624	13.01
Speckled dace	0	141	853	286	54	8	1	0	0	36	1,379	11.05
Unidentified minnow	0	0	0	0	0	0	0	0	0	46	46	0.37
Bluehead sucker	0	4	863	874	1,564	774	141	6	0	77	4,303	34.47
Flannelmouth sucker	0	1	4	51	632	554	174	15	0	8	1,439	11.53
White sucker	0	1	16	69	371	277	11	1	0	0	746	5.98
Longnose sucker	0	0	0	0	0	1	1	0	0	0	2	0.02
Unidentified sucker	0	0	3	13	53	23	7	2	0	28	129	1.03
Plains killifish	0	1	0	0	0	0	0	0	0	0	1	0.01
Total	-	-	-	-	-	-	-	-	-	-	12,482	100.00

Number of samples: 35; % native fishes: 79.12; % non-native fishes: 20.89

Table J.3. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 2, Gunnison River, Colorado, 3 August 1992.

	Total Length Class (mm)											
Species	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40	Unmeasured	Total	Percent Composition
Red shiner	0	89	172	4	0	0	4	4	1	3	277	20.31
Common carp	0	0	0	0	1	0	0	0	0	0	1	0.07
Roundtail chub	0	0	0	14	60	93	68	12	1	0	248	18.18
Sand shiner	0	4	71	127	43	7	5	1	3	0	261	19.13
Fathead minnow	0	27	123	149	57	7	2	0	0	0	365	26.76
Speckled dace	0	0	5	10	17	11	4	0	0	0	47	3.45
Unidentified minnow	0	0	1	0	0	0	0	0	0	4	5	0.37
Bluehead sucker	0	0	2	32	63	41	14	3	0	0	155	11.36
Flannelmouth sucker	0	0	0	0	1	0	1	2	1	0	5	0.37
White sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Plains killifish	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	-	-	-	-	-	-	-	-	-	-	1,364	100.00

Number of samples: 7; % native fishes: 34.31; % non-native fishes: 65.69

Table J.4. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 3, Gunnison River, Colorado, 4 August 1992.

	Total Length Class (mm)											
Species	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40	Unmeasured	Total	Percent Composition
Red shiner	0	72	50	3	0	0	0	0	0	0	125	8.83
Common carp	0	0	0	0	0	0	0	0	0	0	0	0.00
Roundtail chub	0	0	1	3	11	17	7	0	0	0	39	2.76
Sand shiner	0	5	37	82	12	0	0	0	0	0	136	9.61
Fathead minnow	0	308	451	182	11	1	1	0	0	13	967	68.34
Speckled dace	0	1	7	17	8	2	2	1	0	0	38	2.69
Unidentified minnow	0	0	0	0	0	0	0	0	0	21	21	1.48
Bluehead sucker	0	0	15	44	17	5	3	1	0	0	85	6.01
Flannelmouth sucker	0	0	0	0	1	1	1	0	0	0	3	0.21
White sucker	0	0	0	0	0	1	0	0	0	0	1	0.07
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Plains killifish	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	-	-	-	-	-	-	-	-	-	-	1,415	100.00

Number of samples: 7; % native fishes: 18.52; % non-native fishes: 81.48

Table J.5. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 4, Gunnison River, Colorado, 7 August 1992.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	9	25	3	2	0	0	0	4	0	43	4.82
Common carp	0	0	0	0	0	0	0	0	0	0	0	0.00
Roundtail chub	0	1	0	3	14	34	26	3	1	0	82	9.19
Sand shiner	0	1	17	49	28	1	0	1	3	0	100	11.21
Fathead minnow	3	217	207	92	35	10	1	0	1	2	568	63.68
Speckled dace	0	0	5	10	8	3	3	1	1	0	31	3.48
Unidentified minnow	0	1	0	0	0	0	0	0	0	1	2	0.22
Bluehead sucker	0	0	1	19	24	6	3	4	2	0	59	6.61
Flannelmouth sucker	0	0	0	0	0	1	1	2	1	0	5	0.56
White sucker	0	0	0	0	0	1	0	0	0	0	1	0.11
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Plains killifish	0	0	0	0	0	0	0	0	1	0	1	0.11
Total	-	-	-	-	-	-	-	-	-	-	892	100.00

Number of samples: 9; % native fishes: 19.84; % non-native fishes: 80.16

Table J.6. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 5, Gunnison River, Colorado, 5 August 1992.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	8	2	0	3	1	0	0	0	0	14	0.54
Common carp	0	0	0	2	1	0	0	0	0	0	3	0.12
Roundtail chub	0	0	1	4	5	3	0	0	0	0	13	0.51
Sand shiner	0	0	2	1	0	0	0	0	0	0	3	0.12
Fathead minnow	1	559	975	606	120	24	3	0	0	19	2,307	89.76
Speckled dace	0	0	6	32	26	6	0	0	0	0	70	2.72
Unidentified minnow	0	1	2	0	0	0	0	0	0	34	37	1.44
Bluehead sucker	0	0	17	33	16	11	1	0	0	0	78	3.04
Flannelmouth sucker	0	0	0	0	2	5	1	1	0	0	9	0.35
White sucker	0	0	0	6	3	5	4	1	0	0	19	0.74
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Plains killifish	0	0	0	5	6	3	2	0	1	0	17	0.66
Total	-	-	-	-	-	-	-	-	-	-	2,570	100.00

Number of samples: 12; % native fishes: 6.61; % non-native fishes: 93.39

Table J.7. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 2, Gunnison River, Colorado, 6 August 1993.

Species	Total Length Class (mm) 0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40	Unmeasured	Total	Percent Composition
Red shiner	0	0	0	0	0	1	2	1	0	0	4	0.28
Common carp	0	11	7	0	0	0	0	0	0	0	18	1.28
Roundtail chub	0	10	200	162	116	12	0	0	0	15	515	36.47
Sand shiner	0	0	0	0	0	0	0	0	0	0	0	0.00
Fathead minnow	0	6	2	2	2	1	0	0	0	1	14	0.99
Speckled dace	0	28	196	74	30	5	1	0	0	12	346	24.50
Unidentified minnow	0	0	0	0	0	0	0	0	0	11	11	0.78
Bluehead sucker	0	3	107	94	109	87	25	1	0	7	433	30.67
Flannelmouth sucker	0	0	0	2	18	27	17	2	0	0	66	4.67
White sucker	0	0	0	1	2	1	0	0	0	0	4	0.28
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	1	0	0	0	0	0	0	0	1	0.08
Plains killifish	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	-	-	-	-	-	-	-	-	-	-	1,412	100.00

Number of samples: 10; % native fishes: 96.31; % non-native fishes: 3.69

Table J.8. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 3, Gunnison River, Colorado, 5 August 1993.

Species	Total Length Class (mm) 0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40	Unmeasured	Total	Percent Composition
Red shiner	0	0	0	0	0	0	1	0	0	0	1	0.12
Common carp	0	5	1	0	0	0	0	0	0	0	6	0.71
Roundtail chub	0	6	193	68	32	1	0	0	0	20	320	37.60
Sand shiner	0	0	0	0	0	0	0	0	0	0	0	0.00
Fathead minnow	0	4	2	0	0	0	0	0	0	0	6	0.71
Speckled dace	0	44	71	16	4	2	0	0	0	5	142	16.69
Unidentified minnow	0	0	0	0	0	0	0	0	0	1	1	0.12
Bluehead sucker	0	0	183	39	55	17	4	0	0	10	308	36.19
Flannelmouth sucker	0	1	4	9	30	17	2	0	0	0	63	7.40
White sucker	0	0	1	0	0	0	0	0	0	0	1	0.12
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	0	1	0	1	0	0	0	1	3	0.35
Plains killifish	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	-	-	-	-	-	-	-	-	-	-	851	100.00

Number of samples: 7; % native fishes: 97.88; % non-native fishes: 2.12

Table J.9. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 4, Gunnison River, Colorado, 4 August 1993.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	6	1	0	1	0	3	4	0	0	15	0.26
Common carp	0	1	0	0	0	0	0	0	0	0	1	0.02
Roundtail chub	0	0	229	426	727	248	12	0	0	41	1,683	29.33
Sand shiner	0	4	3	0	0	0	0	0	0	0	7	0.12
Fathead minnow	2	717	90	0	0	3	3	1	0	25	841	14.66
Speckled dace	0	13	61	38	9	1	0	0	0	4	126	2.20
Unidentified minnow	0	0	0	0	0	0	0	0	0	23	23	0.40
Bluehead sucker	0	1	415	271	900	525	107	5	0	39	2,263	39.44
Flannelmouth sucker	0	0	0	12	228	322	127	8	0	3	700	12.20
White sucker	0	0	1	4	19	24	2	1	0	0	51	0.89
Longnose sucker	0	0	0	0	0	1	1	0	0	0	2	0.03
Unidentified sucker	0	0	0	3	5	0	5	2	0	10	25	0.44
Plains killifish	0	1	0	0	0	0	0	0	0	0	1	0.02
Total	-	-	-	-	-	-	-	-	-	-	5,738	100.00

Number of samples: 6; % native fishes: 83.17; % non-native fishes: 17.83

Table J.10. Relative abundance and number of larval fishes collected, by 5-mm length groups, from reach 5, Gunnison River, Colorado, 3 August 1993.

Species	Total Length Class (mm)									Unmeasured	Total	Percent Composition
	0-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	>40			
Red shiner	0	0	0	1	0	0	0	0	0	0	1	0.02
Common carp	0	1	0	0	0	0	0	0	0	0	1	0.02
Roundtail chub	0	2	49	56	93	33	4	0	0	0	237	5.29
Sand shiner	0	2	0	0	0	0	0	2	0	0	4	0.90
Fathead minnow	0	525	133	25	17	14	13	3	0	33	763	17.03
Speckled dace	0	56	525	158	11	0	0	0	0	15	765	17.07
Unidentified minnow	0	0	0	0	0	0	0	0	0	11	11	0.25
Bluehead sucker	0	0	158	470	500	145	5	0	0	21	1,299	28.99
Flannelmouth sucker	0	0	0	28	356	188	28	5	0	5	610	13.61
White sucker	0	1	14	64	350	252	9	0	0	0	690	15.40
Longnose sucker	0	0	0	0	0	0	0	0	0	0	0	0.00
Unidentified sucker	0	0	2	9	48	22	2	0	0	17	100	2.23
Plains killifish	0	0	0	0	0	0	0	0	0	0	0	0.00
Total	-	-	-	-	-	-	-	-	-	-	4,481	100.00

Number of samples: 12; % native fishes: 64.96; % non-native fishes: 35.04

APPENDIX K
Catch Statistics for Post-Larval Fishes, 1992 and 1993

Table K.1. Catch statistics for post-larval fishes collected by seining from Redlands Diversion Dam to Hartland Diversion Dam, Gunnison River, Colorado, September 1992.

Reaches 2-5 (River Mile: 3.1-59.9)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	1,960	8.53	4.41	3	32
common carp	9	0.04	0.02	10	6
roundtail chub	416	1.81	0.94	6	18
sand shiner	4,489	19.53	10.10	2	29
fathead minnow	13,846	60.23	31.15	1	35
Colorado squawfish	0	--	--	--	0
speckled dace	573	2.49	1.29	5	19
white sucker	260	1.13	0.58	7	14
bluehead sucker	1,063	4.62	2.39	4	33
flannelmouth sucker	260	1.13	0.58	7	17
razorback sucker	0	--	--	--	0
black bullhead	1	< 0.01	< 0.01	12	1
channel catfish	0	--	--	--	0
plains killifish	66	0.29	0.15	8	6
green sunfish	40	0.17	0.09	9	12
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	5	0.02	0.01	11	4
TOTAL	22,988	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reaches 2-5.

[b] Percent of the total number of fishes in reaches 2-5.

[c] Number of samples: 42.

Total area sampled: 4,446 m^2.

Table K.2. Catch statistics for post-larval fishes collected by seining from Redlands Diversion Dam to Whitewater, Gunnison River, Colorado, September 1992.

Reach 2 (River Mile: 3.1-15.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	143	7.19	1.60	3	5
common carp	0	--	--	--	0
roundtail chub	25	1.25	0.26	6	3
sand shiner	1,127	56.96	12.58	1	5
fathead minnow	388	19.72	4.33	2	5
Colorado squawfish	0	--	--	--	0
speckled dace	138	6.94	1.54	4	4
white sucker	3	0.15	0.03	8	1
bluehead sucker	128	6.94	1.43	5	5
flannelmouth sucker	18	0.85	0.20	7	2
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	0	--	--	--	0
green sunfish	0	--	--	--	0
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	0	--	--	--	0
TOTAL	1,970	100.0	--	--	-

[a] CPUE (total catch per unit of effort) in reach 2.

[b] Percent of the total number of fishes in reach 2.

[c] Number of samples: 6.

Total area sampled: 896 m^2.

Table K.3. Catch statistics for post-larval fishes collected by seining from Whitewater to Bridgeport, Gunnison River, Colorado, September 1992.

Reach 3 (River Mile: 15.1-30.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	637	10.52	6.26	3	9
common carp	1	0.02	0.01	10	1
roundtail chub	134	2.22	1.32	5	4
sand shiner	2,399	39.66	23.57	2	8
fathead minnow	2,371	39.19	23.29	1	8
Colorado squawfish	0	--	--	--	0
speckled dace	14	0.23	0.14	8	3
white sucker	7	0.11	0.07	9	1
bluehead sucker	420	6.94	4.13	4	9
flannelmouth sucker	37	0.61	0.36	6	3
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	0	--	--	--	0
green sunfish	29	0.48	0.28	7	4
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	1	0.02	0.01	10	1
TOTAL	6,050	100.0	--	--	-

[a] CPUE (total catch per unit of effort) in reach 3.

[b] Percent of the total number of fishes in reach 3.

[c] Number of samples: 10.

Total area sampled: 1,018 m^2.

Table K.4. Catch statistics for post-larval fishes collected by seining from Bridgeport to Escalante Bridge, Gunnison River, Colorado, September 1992.

Reach 4 (River Mile: 30.1-42.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	786	16.16	7.57	2	10
common carp	4	0.08	0.04	7	2
roundtail chub	42	0.87	0.40	5	5
sand shiner	217	4.47	2.09	3	7
fathead minnow	3,732	74.70	35.95	1	10
Colorado squawfish	0	--	--	--	0
speckled dace	5	0.10	0.05	6	3
white sucker	5	0.10	0.05	6	3
bluehead sucker	46	0.95	0.44	4	8
flannelmouth sucker	21	0.43	0.20	6	3
razorback sucker	0	--	--	--	0
black bullhead	1	0.02	0.01	8	1
channel catfish	0	--	--	--	0
plains killifish	1	0.02	0.01	8	1
green sunfish	5	0.10	0.05	6	3
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	0	--	--	--	0
TOTAL	4,865	100.0	--	--	-

[a] CPUE (total catch per unit of effort) in reach 4.

[b] Percent of the total number of fishes in reach 4.

[c] Number of samples: 10.

Total area sampled: 1,038 m^2.

Table K.5. Catch statistics for post-larval fishes collected by seining from Escalante Bridge to Hartland Diversion Dam, Gunnison River, Colorado, September 1992.

Reach 5 (River Mile: 42.1-59.9)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	394	3.90	2.64	5	8
common carp	4	0.04	0.03	10	3
roundtail chub	215	2.13	1.44	7	6
sand shiner	746	7.38	4.99	2	9
fathead minnow	7,355	72.80	49.23	1	12
Colorado squawfish	0	--	--	--	0
speckled dace	416	4.12	2.78	4	9
white sucker	245	2.43	1.64	6	9
bluehead sucker	469	4.64	3.14	3	11
flannelmouth sucker	184	1.82	1.23	8	9
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	65	0.64	0.44	9	5
green sunfish	6	0.06	0.04	11	5
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	4	0.04	0.03	12	3
TOTAL	10,103	100.0	--	--	-

[a] CPUE (total catch per unit of effort) in reach 5.

[b] Percent of the total number of fishes in reach 5.

[c] Number of samples: 16.

Total area sampled: 1,494 m^2.

Table K.6. Catch statistics for post-larval fishes collected by seining from Redlands Diversion Dam to Hartland Diversion Dam, Gunnison River, Colorado, September 1993.

Reaches 2-5 (River Mile: 3.1-59.9)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m²)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	753	3.15	2.22	8	38
common carp	32	0.13	0.09	13	11
roundtail chub	1,933	8.08	5.70	5	54
sand shiner	975	4.08	2.88	7	38
fathead minnow	5,993	25.06	17.67	2	52
Colorado squawfish	0	--	--	--	0
speckled dace	1,960	8.19	5.78	4	39
longnose sucker	109	0.46	0.32	10	21
white sucker	1,589	6.64	4.69	6	45
bluehead sucker	7,060	29.52	20.82	1	56
flannelmouth sucker	3,041	12.71	8.97	3	26
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	39	0.16	0.12	12	12
green sunfish	99	0.41	0.29	11	16
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	335	1.40	0.99	9	42
TOTAL	23,918	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reaches 2-5.

[b] Percent of the total number of fishes in reaches 2-5.

[c] Number of samples: 60.

Total area sampled: 3,391 m^2.

Table K.7. Catch statistics for post-larval fishes collected by seining from Redlands Diversion Dam to Whitewater, Gunnison River, Colorado, September 1993.

Reach 2 (River Mile: 3.1-15.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	129	6.59	5.04	4	4
common carp	0	--	--	--	0
roundtail chub	295	15.07	11.52	2	5
sand shiner	94	4.80	3.67	5	4
fathead minnow	37	1.89	1.45	7	4
Colorado squawfish	0	--	--	--	0
speckled dace	76	3.88	2.97	6	4
longnose sucker	0	--	--	--	0
white sucker	15	0.77	0.59	8	3
bluehead sucker	1,075	54.93	41.99	1	5
flannelmouth sucker	229	11.70	8.95	3	6
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	0	--	--	--	0
green sunfish	0	--	--	--	0
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	7	0.36	0.27	9	4
TOTAL	1,957	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reach 2.

[b] Percent of the total number of fishes in reach 2.

[c] Number of samples: 6.

Total area sampled: 256 m^2.

Table K.8. Catch statistics for post-larval fishes collected by seining from Whitewater to Bridgeport, Gunnison River, Colorado, September 1993.

Reach 3 (River Mile: 15.1-30.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	34	2.08	1.21	6	6
common carp	0	--	--	--	0
roundtail chub	295	18.05	10.54	3	10
sand shiner	22	1.35	0.79	8	5
fathead minnow	721	44.18	25.75	1	8
Colorado squawfish	0	--	--	--	0
speckled dace	65	3.98	2.33	5	3
longnose sucker	0	--	--	--	0
white sucker	25	1.53	0.89	7	2
bluehead sucker	297	18.20	10.61	2	8
flannelmouth sucker	132	8.09	4.71	4	7
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	3	0.18	0.11	10	2
green sunfish	16	0.98	0.57	9	4
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	22	1.35	0.79	8	5
TOTAL	1,632	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reach 3.

[b] Percent of the total number of fishes in reach 3.

[c] Number of samples: 10.

Total area sampled: 280 m^2.

Table K.9. Catch statistics for post-larval fishes collected by seining from Bridgeport to Escalante Brdige, Gunnison River, Colorado, September 1993.

Reach 4 (River Mile: 30.1-42.0)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	281	3.98	5.61	7	8
common carp	15	0.21	9.98	6	4
roundtail chub	518	7.34	10.34	5	9
sand shiner	260	3.68	5.19	8	8
fathead minnow	2,740	38.82	54.69	1	9
Colorado squawfish	0	--	--	--	0
speckled dace	99	1.40	1.98	10	7
longnose sucker	4	0.06	0.08	12	3
white sucker	143	2.03	2.85	9	7
bluehead sucker	1,944	27.54	38.80	2	9
flannelmouth sucker	994	14.08	19.84	3	9
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	1	0.01	0.02	13	1
green sunfish	9	0.13	17.96	4	3
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	51	0.72	1.02	11	7
TOTAL	7,059	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reach 4.

[b] Percent of the total number of fishes in reach 4.

[c] Number of samples: 9.

Total area sampled: 501 m^2.

Table K.10. Catch statistics for post-larval fishes collected by seining from Escalante Bridge to Hartland Diversion Dam, Gunnison River, Colorado, September 1993.

Reach 5 (River Mile: 42.1-59.9)

Common Name	Number of fish	Percentage Composition[b]	CPUE[a] (Fish/10m^2)	Ranked CPUE[a]	Frequency of Occurrence in Samples[c]
northern pike	0	--	--	--	0
red shiner	309	2.32	1.31	8	20
common carp	17	0.13	0.07	13	7
roundtail chub	825	6.22	3.50	6	30
sand shiner	599	4.51	2.54	7	21
fathead minnow	2,495	18.80	10.60	2	31
Colorado squawfish	0	--	--	--	0
speckled dace	1,720	12.96	7.31	3	25
longnose sucker	105	0.80	0.45	10	18
white sucker	1,406	10.60	5.97	5	33
bluehead sucker	3,744	28.21	15.90	1	34
flannelmouth sucker	1,686	12.70	7.16	4	35
razorback sucker	0	--	--	--	0
black bullhead	0	--	--	--	0
channel catfish	0	--	--	--	0
plains killifish	35	0.26	0.15	12	9
green sunfish	74	0.56	0.31	11	9
smallmouth bass	0	--	--	--	0
largemouth bass	0	--	--	--	0
mottled sculpin	0	--	--	--	0
Unknown hybrid suckers	255	2.65	1.08	9	26
TOTAL	13,270	100.0	--	--	--

[a] CPUE (total catch per unit of effort) in reach 5.

[b] Percent of the total number of fishes in reach 5.

[c] Number of samples: 35.

Total area sampled: 2,354 m^2.

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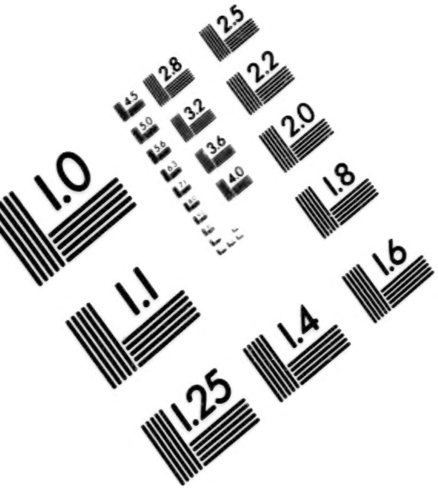

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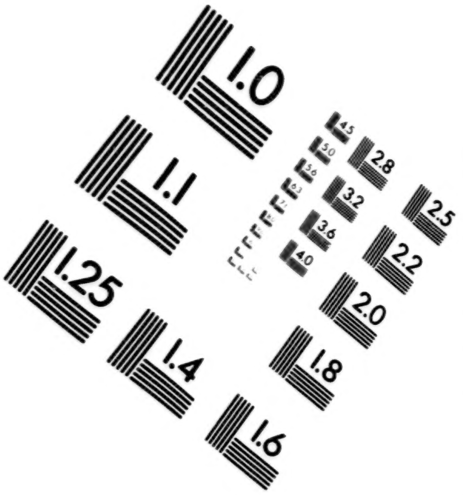

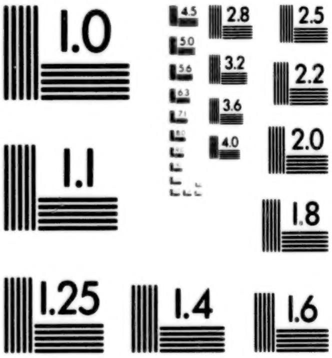

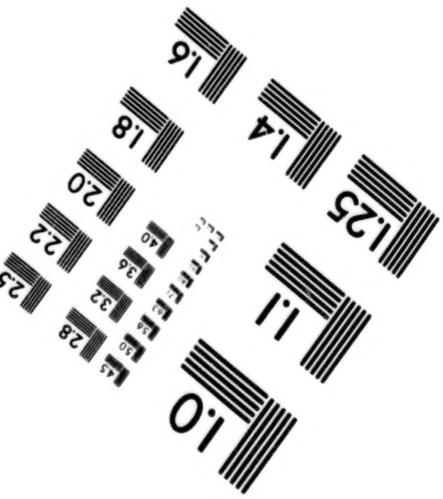

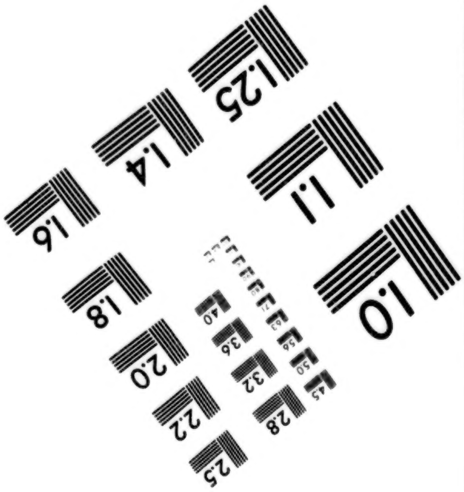

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